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CONTENTS.

ARTICLES. PAGE
1. Offensive and Defensive Torpedo War. By Capt. S. P. OLIVER, (late) R.A. 287
2. The Soul: What is it? 298
3. Internal Enemies 305
4. The Antiquity of Mankind .. 310

LECTURES.
On Water and Air. By Prof. TYNDALL, D.C.L., LL.D., F.R.S. 317

ANALYSES OF BOOKS.
Evolution and Involution 334
The Spectroscope in Medicine .. 335
A History of the British Marine Polyzoa 337

ANALYSES OF BOOKS—*continued.* PAGE
Science Primers: Introductory.. 338
The Geological Record for 1877 338

CORRESPONDENCE.
"Instinct and Mind" 339
The Wild Birds Protection Act 340
The Ancestry of Man 340
Carnivorous Bees.. 341
Fertility of Hybrids 341
Paucity of Almond Blossoms, &c. 342
The Colour-Sense.. 342
The Meaning of Beauty 342

NOTES 344

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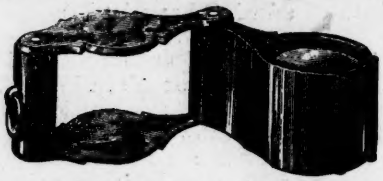

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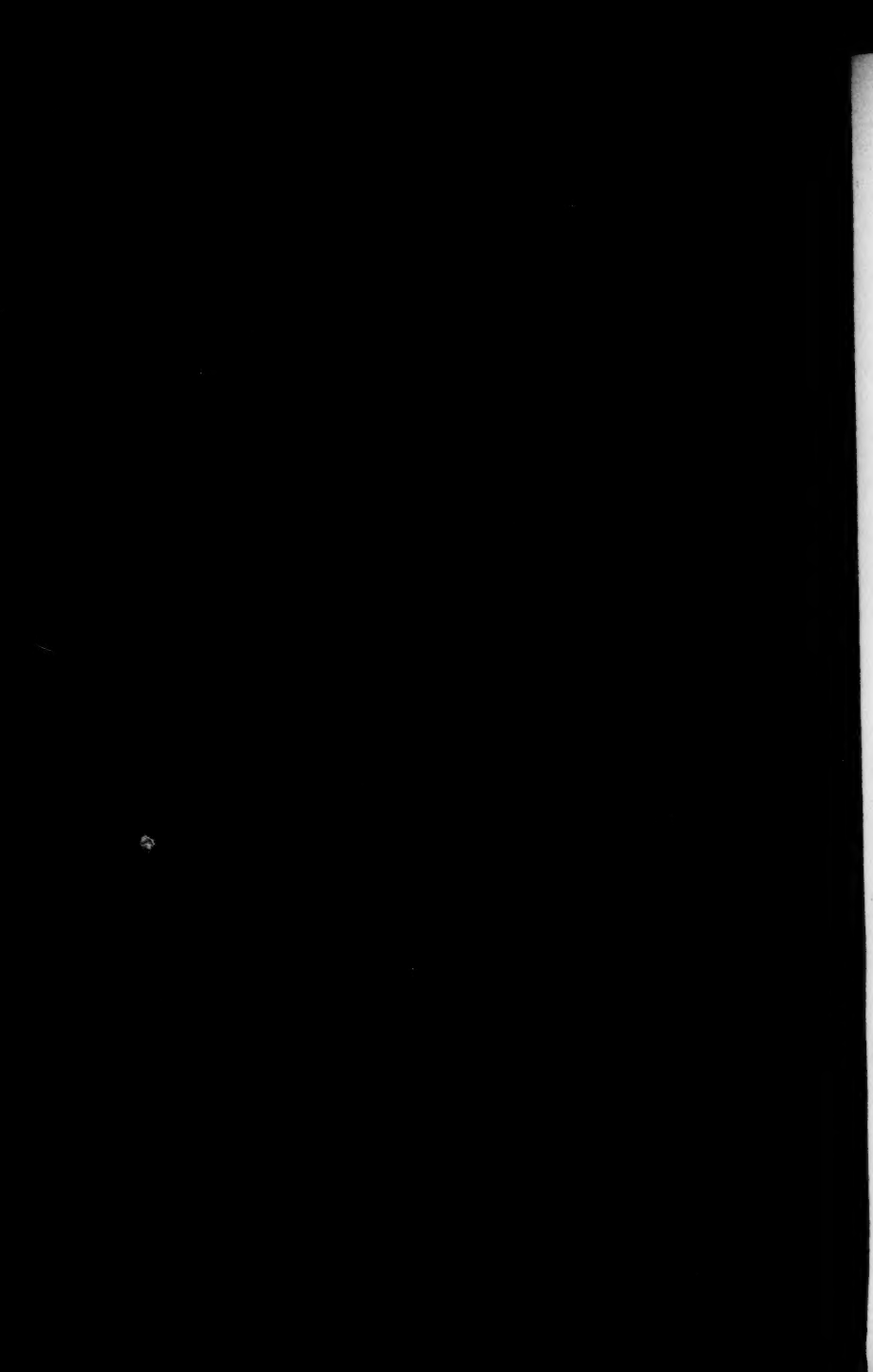


THE

JOURNAL OF SCIENCE.

MAY, 1880.

I. OFFENSIVE AND DEFENSIVE TORPEDO WAR.

By Capt. S. P. OLIVER, (late) R.A.

PART II.

IN the last paragraph of my former paper I had only just time, before the MS. went to press, to allude to the tragical event which occurred at the Winter Palace on the 17th of February. In connection with this affair it may be as well to remind ourselves that it is not always Imperial and dynastic representatives who are the destined victims of assassination by means of infernal machinery, as we are too apt to think, as such means have been used by the Royalist party when in a minority against a Republican chief; witness the attempt against Buonaparte by the Chouanists, which in many respects is a parallel case to the recent incident at St. Petersburg. We may mention briefly the circumstances as stated by Napoleon himself subsequently at St. Helena, to the Count de Las Cases, on the 28th October, 1815, and which is thus recorded in the journal of the latter:*—"In the course of the conversation this day the Emperor adverted to the numerous conspiracies which had been formed against him. The infernal machine was mentioned in its turn. This diabolical invention, which gave rise to so many conjectures, and caused the death of so many victims, was the work of the Royalists, who obtained the first idea of it from the Jacobins. The Emperor

* Memoirs of the Life, Exile, and Conversations of the Emperor Napoleon By the Count DE LAS CAS. Vol. i., p. 238. (Colburn, 1836.)

stated that a hundred furious Jacobins—the real authors of the scene of September, the 10th August, &c.—had resolved to get rid of the First Consul, for which purpose they invented a 15- or 16-pound howitzer (*sic*) [howitzer-shell ?], which on being thrown into the carriage would explode by its own concussion, and hurl destruction on every side. To make sure of their object they proposed to lay *chevaux de frise* along a part of the road, which, by suddenly impeding the horses, would of course render it impossible for the carriage to move on. The man who was employed to lay down the *chevaux de frise*, entertaining some suspicions of the job which he had been set upon, as well as of the morality of his employers, communicated the business to the police. The conspirators were soon traced, and were apprehended near the Jardin des Plantes, in the act of trying the effect of the machine, which made a terrible explosion. The First Consul, whose policy it was not to divulge the numerous conspiracies of which he was the object, did not give publicity to this, but contented himself with imprisoning the criminals. He soon relaxed his orders for keeping them in close confinement, and they were allowed a certain degree of liberty. In the same prison in which these Jacobins were confined some Royalists were also imprisoned for an attempt to assassinate the First Consul, by means of air-guns. These two parties formed a league together; and the Royalists transmitted to their friends out of prison the idea of the infernal machine, as being preferable to any other plan of destruction.

It is very remarkable that, on the evening of the catastrophe, the Emperor expressed an extreme repugnance to go out. Madame Buonaparte and some intimate friends absolutely forced him to go to an oratorio. They roused him from a sofa where he was fast asleep; one fetched his sword, and another his hat. As he drove along in his carriage he fell asleep again, and awoke suddenly, saying that he had dreamed he was drowning in the Tagliamento. (To explain what he alluded to it is necessary to mention that some years previously, when he was General of the Army of Italy, he passed the Tagliamento in his carriage during the night, contrary to the advice of everyone about him. In the ardour of youth, and heedless of every obstacle, he crossed the river, surrounded by a hundred men armed with poles and torches. His carriage was, however, soon set afloat; Napoleon incurred the most imminent danger, and for some minutes gave himself up for lost.) At the moment when he now awoke, on his way to the oratorio, he was in the midst

of a conflagration, the carriage was lifted up, and the passage of the Tagliamento came fresh upon his mind. The illusion, however, was but momentary; a dreadful explosion immediately ensued. "We are blown up!" exclaimed the First Consul to Lannes and Bessieres, who were in the carriage with him. They were for stopping the carriage, but the First Consul enjoined them not to do it on any account. He arrived safe, and appeared at the Opera as though nothing had happened. He was preserved by the desperate driving of his coachman. The machine injured only one or two individuals who closed the escort.

The most trivial circumstances often lead to the most important results. The coachman was intoxicated, and there is no doubt that this proved the means of saving the life of the First Consul. The man's intoxication was so great that it was not until next morning he could be made to comprehend what had happened. He had taken the explosion for the firing of a salute. Immediately after this event measures were adopted against the Jacobins who had been convicted of meditating the crime, and a considerable number were banished. They, however, were not the real criminals, whose discovery was brought about by another very singular chance. Three or four hundred drivers of *fiacres* subscribed a louis or twelve francs each, to give a dinner to the First Consul's coachman, who had become the hero of the day and the boast of his profession. During the feast one of the guests, drinking to the health of the First Consul's coachman, observed that he knew who had played him the trick, —alluding to the explosion of the machine. He was immediately arrested; and it appeared that on the very night, or the night preceding the explosion, he had drawn up his *fiacre* beside a gate, whence had issued a little cart that had done all the mischief. The police proceeded to the place, and it was found to be a coach-yard, where all kinds of vehicles were lent on hire. The keepers of the yard did not deny the fact; they pointed out the stall in which the cart stood: it still presented traces of gunpowder. The proprietors declared that they were given to understand the cart had been hired by some Bretons who were concerned in smuggling. The man who had sold the horse, together with every individual who had participated in the affair, were easily traced out, and it was proved that the plot had been formed by some Chouan Royalists. Some active and intelligent men were despatched to their head-quarters in Morbihan. They took no pains to conceal their share in the transaction, and only regretted that it had not succeeded. Some of them

were apprehended and brought to punishment.* It is said that the chief conspirator afterwards turned Trappist, and sought to expiate his crime by religious austerities."

Such were two of the many plots against Napoleon, who, in adverting to the many attempts that had been made to assassinate him (such as those disclosed during the enquiry into the conspiracy of Charles d'Hosier, Moreau, Georges, and Pichegru), observed that he was bound in justice to say that he had never detected Louis XVIII. in any *direct* conspiracy against his life, though such plots had been incessantly renewed in other high quarters. The following is significant:—"If," said Napoleon, "I had continued in France in 1815, I intended to have given publicity to some of the later attempts that were made against me. The *Maubreuil* affair, in particular, should have been investigated by the First Consul of the Empire, and Europe would have shuddered to see to what an extent the crime of secret assassination could be carried."—(*Id.*, vol. ii., p. 226.)

In a Lecture given before the United Service Institution, February 15th, 1878, by Admiral the Right Hon. Lord Dunsany, "On the Laws and Customs of War, as limiting the use of Fire-ships, Explosion Vessels, Torpedoes, and Submarine Mines," we were told "Some of the old jurists of the highest authority justify assassination and poisoning." Wheaton, a standard American authority, tells us—"Even such institutionary writers as Bynkershoek or Wolf, who lived in the most learned and not the least civilised countries of Europe, at the commencement of the 18th century, assert the broad principle that everything done against an enemy is lawful; that he may be destroyed, though unarmed and helpless; that fraud, and even poison, may be employed against him; and that an unlimited right is acquired by the victor to his person and property. Such, however, was not the sentiment and practice of enlightened Europe at the

* The two principal conspirators were Arena and Cerachi, although they were doubtless inspired on this occasion, in 1800, by far higher and aristocratic Royalist plotters. Since this attempt forty-one murderous attacks have been made on Royal personages and Rulers of States, including three attacks on our own Queen, four on the person of the Emperor of Germany; five of these attempts were directed against the present Czar—in 1866, 1867, and three times within the last twelve months have they been renewed. The assassination of Napoleon III. was intended on seven occasions, and the life of his predecessor, Louis Philippe, was attempted six times within eleven years. Very few assassinations were successful, viz., those five murders which reckon as their victims Paul II., Emperor of Russia, strangled in 1801; Prince Obrenovitch, of Servia, killed in 1868; President Lincoln, shot in 1865; President Morenos, assassinated in 1875; and President Gill, of Paraguay, murdered in 1877. The execution of the Emperor Maximilian, of Brazil, can hardly be included in this category.

time they wrote, since Grotius had long before inculcated a more humane principle." In the same lecture Lord Dunsany alludes to the use of the coal-torpedoes, mentioned in my previous notice (see page 174), as a variety of warfare practised by the Confederates "which would certainly be more honoured in the breach than in the observance. That we find detailed in the 'Edinburgh Review' (October, 1877). I call your attention to it because it certainly seems to be on the verge of the lawful,* if it is not beyond it. The particular means of explosion consisted of a hollow lump of iron filled with a charge of dynamite. It was rubbed over with coal-tar and dust, and exactly resembled a large lump of coal. I am not sure whether it was used with success, but it certainly was used by the Confederates." In the discussion which followed the reading of the above-named paper Major E. H. Cameron, Instructor Royal Laboratory Dept., Woolwich, said as follows:—"He" (Lord Dunsany) "had also instanced explosive coal lumps, and I think gives the credit of that, or the discredit, to the Confederates. I can only say I have had one of those lumps in my own hands which came from the Northern side, and was intended by Northern cruisers to have been put on board blockade-runners, who were to have been allowed to proceed on their mission, to discharge their cargo into the bunkers of Confederate cruisers, and thus the explosive coal-lump was to have produced its unhappy results when least expected." Since I wrote my paper (in the No. for March) I have myself obtained one of these coal-shells from the gentleman who, under the pseudonym of "War-hawk," warned the public seven years since of their manufacture. I shall place it in the Museum of the Royal United Service Institution for public inspection. Has anyone seen the so-called *bullets-asphyxiants?*

There is no doubt that publicity to all secret contrivances is the best method of combating their use for mischievous purposes; thus, for instance, a brass-founder when required to make certain casts would have his suspicions aroused did the models ordered resemble blocks of coal, had he heard of these diabolical bombs. It is only on this plea of public utility that I have ventured to bring to notice in the pages of the "Journal of Science" such apparently digressive

* The Right Honble. Montague Bernard, the distinguished jurist, referring to the above, said, "For my part I confess that the sending an infernal machine that looks like a mere piece of coal into an enemy's country is worse to my mind than even poisoning an enemy's officer, because you cannot foresee what destruction it may cause or who may be the sufferers. I can conceive nothing that falls more thoroughly within the description of an unfair mode of warfare than that."

matter, and, after apologising for the interpolation, now resume my remarks upon the more legitimate methods of torpedo warfare.

In the former article, called forth by the publication of Commander Sleeman's work, I alluded chiefly to the offensive attack by torpedo-boats armed with the spar and Whitehead or locomotive torpedoes, instancing the few occasions on which such attacks had been successful in real warfare; and I now proceed to point out that, whilst the means of active attack and defence—especially whilst *on the move*—have lately been greatly developed, still the improvements have added yet more to the odds on the side of defence than in proportion to the new modes of offence.

We may take the latter first.

In the "Révue Maritime et Coloniale" there have been some interesting papers by Le Lieutenant Chaband Arnault, translations from which have been published by Lieut. E. Meryon, R.N., in the "Journal of the Royal United Service Institution," in the last number of which we find, among the results arrived at, the following conclusions, which the author considers as established from "the conscientious examination of the different sea-fights in which torpedo-boats have taken part." I propose to take them *seriatim*.

(A.) "An attack made against a ship by means of a torpedo-boat does not require more exceptional circumstances nor more absolute devotion than any other operation of naval war." Granted, with a reservation best expressed in the following remark of Sleeman, p. 8:—"The cause of the want of success in war-time with offensive torpedoes lies in the fact that during peace-time the experiments and practice carried out with them are done so under the most favourable circumstances, that is to say, in daylight, and the nerves of the operators not in that high state of tension which would be the case were they attacking a man-of-war on a pitch-dark night, whose exact position cannot be known, and from whose guns at any moment a sheet of fire may be belched forth, and a storm of shot and bullets be poured on them whilst on actual service; this would in nine out of ten instances be the case. Some uncertainty must and will always exist in offensive torpedo operations when carried out in actual war, where, as in this case, the success of the enterprise depends almost wholly on the state of a man's nerves; yet this defect, a want of certainty, may to a considerable extent be eradicated were means to be found of carrying out in time of peace a systematic practice of this branch of torpedo warfare under circumstances similar to those expe-

rienced in war-time; and this is not only possible, but practicable." Here it should be observed that it is not only *pluck* and *devotion*, but a steadiness of nerve, that is most important. There is many a brave man capable of leading a forlorn hope in storming a breach, and hand-to-hand combat whilst boarding an enemy's ship or blowing in a stockade, and such other feats in which excitement and passion of combat are incentives to daring deeds; but it requires a different class of cold-blooded, phlegmatic temperament to manipulate delicate adjustments with a quiet pulse, free from all excitement or apprehension of the immediate neighbourhood of sudden death. It is like the comparison of the spirit of a prize-fighter with that of a surgeon during a mortal operation.

(B.) "An attack of this description, where the assailant only risks forces relatively small, offers such chances of success that it should always be tried when the occasion presents itself." This is a self-evident proposition, as the *matériel* and *personnel* exposed by the assailants to the fire of the enemy is hardly worth mentioning in comparison with the amount of damage to be perpetrated: for instance, a small Yarrow boat *versus* the *Inflexible!*

(C.) "One single torpedo-boat of moderately good quality is sufficient to surprise at night a vessel at anchor; a day attack on a vessel under weigh requires the co-operation of several torpedo-boats, especially built for the purpose." Lord Dunsany instances the exploit of the Russian steamer yacht *Constantine*, who sent off her torpedo-cutter against the Turkish ironclad guardship at Batoum, and destroyed the latter. He says, "A point I would call your attention to is the very small risk to the torpedo crew at which the wholesale destruction is effected. The huge guns of the present day make excellent practice; but they fire very slowly, and, so far as I could judge, the chances of hitting a torpedo-boat in motion would be *nil*."* The *Duilio* would be nigh powerless against a small flotilla of swift Yarrow or Thorneycroft boats with bow-rudders, able to dart their Woolwich torpedoes from their outriggers on all sides. Behemoth amid a shoal of threshers and swordfish must soon succumb.

(D.) "Under all circumstances where such boats, collected into a flotilla, have to attack one or more ships, their attacks should be simultaneous." The majority of actions fought by American and Russian torpedo-boats have been fought

* In the Navy estimates for 1880-81, just submitted to Parliament, we see that fifty-six torpedo-boats are to be constructed by private firms for the British Navy. We should like to see double the number provided for.

without anything like concerted action; but it is manifest that several boats which unite their endeavours distract the attention of their enemy, and augment, if they do not ensure, their chances of success. Hence, says Lieut. Arnault, "A day attack requires special boats, fast, turning rapidly, presenting as small a target as possible to the enemy's gunners, and the crew of which should be absolutely protected against musketry. Grape and case can pierce the boat; but the experience gained at Rustchuk and Nicopolis shows us that if the engines remain unharmed the boat escapes by keeping up a high speed. Hence great lightness of hull, rapidity of movements and turning, small dimensions, musketry protection limited to the machinery and the fighting posts of the crew—such seem to us to be the principal requirements which boats specially built for torpedo fighting should fulfil.

(E.) "The use of 'diverging torpedoes' in boats should be discontinued." Witness the failure of the diverging torpedoes despatched from the *Tchesmé* against the *Assar-i-Chefket*, at the Sulina mouth of the Danube. The fact is the slightest floating protection disarms all towing divergent torpedoes; even a mere rope stretched between two booms will suffice to throw off the tow-line of a Harvey or other similar weapon.

(F.) "Spar torpedoes are usefully employed by boats attacking on a very dark night, or with a slightly agitated sea, a ship moored amongst strong currents, or which may be expected not to be protected by external defences." Commander Sleeman says, "The spar, the Whitehead fish, and the Harvey towing torpedo have each been subjected to the test of actual service, the former weapon being the only one that has under those conditions been successfully used." Taking this fact into consideration, also the high pitch of excellence that has been attained in the construction of steam torpedo-boats, and also the results of the numerous exhaustive experiments that have been from time to time carried on in England, America, and Europe, with various modifications of the locomotive, towing, and spar torpedoes, there can be no two opinions as to which of the numerous species of offensive submarine weapons is the most practicable and effective,—and that is the spar or outrigger torpedo. To manipulate successfully locomotive and towing torpedoes in an attack against hostile vessels, the operators must be not only unusually fearless and self-possessed, but must also possess a thorough practical knowledge of the complicated method of working and manœuvring those weapons—in fact they must be specialists; whilst in the case of the spar torpedo, which may be fired by contact, it is only necessary

to employ men capable of handling a boat well, and possessed of dash and pluck, to ensure an attack by such means being generally successful.

(G.) "Whitehead torpedoes will be employed by preference when the night is comparatively clear, the sea very calm, the current slight, and when one may suppose the enemy's ship to be provided with obstacles." The fish torpedo fired from a boat in close proximity to the attacked vessel, in *smooth* water and unmolested, would sink a vessel, which under the same circumstances, owing to her being protected by booms, might prove impregnable to a spar torpedo attack, but such favourable conditions will not often occur in war-time.

(H.) "Against a vessel under weigh the two species of torpedoes will both respectively find their value according to circumstances. It would appear, then, to be best to combine in a flotilla intended for the defence of harbours and road-steads both spar and Whitehead torpedo-boats. Finally, in certain circumstances, a ship under weigh may defend herself advantageously against torpedo-boats by booms and nets." Such are a few of the principles deduced by Lieut. Arnault from the published accounts of the employment of torpedo-boats against ships, which summed up would seem to give the odds in favour of the attack, but if we examine more closely we shall see that there is something to be said on the other side; for instance, in all the examples, the attack of boats on large ships has been met in all cases by merely passive resistance: in future this will never be the case. It will be a case of "Greek meeting Greek," for every large ship of war will now have its own attendant flotilla of guard-boats, themselves torpedo-vessels,* and an element which we have never yet seen discussed really now enters upon the scene, and must be taken into account—*i.e.*, the manœuvring of torpedo-boat *versus* torpedo-boat. One exciting tournament of this description has already been rehearsed, although the incident did not form part of the programme, the other day, or rather night, at Spithead. It is thus described:—"An accident, which very nearly terminated in the destruction of a couple of torpedo-boats, occurred between 7 and 8 o'clock on the night of the 5th inst., at Spithead. Four second-class Thorneycroft torpedo-boats, attached to the *Hecla*, torpedo store ship, Capt. Morgan Singer, now lying at Spithead, were despatched from the

* On the 27th February, 1880, the Peruvian monitor *Mancocapa* came out o Arica and engaged the famous Chilian *Huascar* at close quarters: the *Huascar* feared to ram her antagonist, "*on account of her having a torpedo-boat in tow*"! The further details will be interesting.

ship soon after dark for practice, each boat taking a different course and being under independent control. The boats of this class, when fully accoutred, carry each three Whitehead locomotive torpedoes, which are discharged in a line with the keel from slings at the side, and the object of the practice, which was of the ordinary routine character, was to endeavour to approach within striking distance of the *Hecla* without being discovered by those on board. It need scarcely be remarked that as the attack was a sham one, and was made during the night, there were no explosive projectiles used on the occasion, the whole practice being confined to evolutions under steam. The hostile craft approached from various points of the compass at about half-speed, or from 6 to 8 knots an hour. Two of the boats, a black one and a grey one, began the attack from the eastward, and when the former drew within a quarter of a mile of the *Hecla* she was noticed and ruled out of the attack. At this moment, while she was lying with her machinery at rest, the grey craft was heard coming at a rapid rate in her direction, those on board apparently not being able to discern her black hull in the water. She was hailed, and though her engines were promptly reversed she struck the stationary boat a violent blow on the port side, breaking one of the plates and doing considerable damage to the angle frames or stiffeners. The water rushed in, but was happily confined to the second or smoke-box water-tight compartment, whereby the buoyancy of the craft was preserved. Had she been struck a couple of feet or so farther aft the engine-room would have been flooded, and probably some of the men severely scalded. Considering that these boats are mere steel shells, not more than one-sixteenth of an inch in thickness, it seems surprising that the stricken boat was not cut in two; and this would undoubtedly have been the case had the momentum of the second boat not been arrested by the wire-rope stay which surrounds the craft at the water-line, and of which only a strand or two were cut. The attacking boat was even worse damaged, her sharp stem being broken and distorted, and the bow plates bent and bulged from their fastenings. The forward collision bulkhead, however, performed its work admirably, and did not permit even so much as a weeping of water to penetrate beyond the foremost compartment. Though both vessels were disabled, no one was injured. The boats were about to be forwarded in the Wivern for use in China, and others will now have to be substituted."

We may expect to see these torpedo-boats used as auxiliary to defence as well as for offensive purposes, and they will

probably develop an armament,* being fitted with the Hotchkiss gun, which fires a shot weighing a pound, penetrating an inch and a half plate at 300 yards; and as the torpedo-boats are seldom more than three-sixteenths of an inch thick, we shall hear no more of the shot-holes being water-proofed by rapid steaming through the water, and even the Fosberry patent india-rubber protective will be of little avail. "*Kieselghur*" is used with success for *extempore* plugging of shot-holes.

There is one observation which should be made before taking leave of this position of the subject, and that is the reply to the question put by Admiral Sir Frederick W. E. Nicolson, Bart., C.B., when presiding at the discussion of Lord Dunsany's paper before mentioned. "The Chairman: I should like to ask Lord Dunsany a question. As I gather from your Lordship's argument, you would treat with stern justice the persons employed in a torpedo-boat. I want to ask you this: that torpedo-boat I presume you send away from a vessel. Supposing subsequently you captured that vessel, in what manner would you treat the Captain or the Admiral flying his flag in the vessel from which the torpedo-boat had been sent?" The answer was skilfully evaded; but this is certain, that on board of all vessels carrying torpedoes and torpedo-boats the crews who man them should be perfectly aware of the risks to which they are exposed at the enemy's hands if captured, in the same way that the crews of fire-ships of olden times perfectly appreciated that they were entitled to no quarter from the enemy. And, moreover, distinct orders should be given by the Admiralty as to the usage to be practised towards all torpedo opponents. Have the Admiralty given any such orders? or is the "*custom of war in like cases*" relied upon as covering all discretion on the subject.†

In the articles of war a paragraph must soon be inserted as to what torpedist operators are to expect at our hands, and if it happens to be inserted "*shall suffer death*" all ambiguity will be avoided without circumlocution. Lord Dunsany said, "One sees many occasions on which a sentimental answer can be given in a moment—'*Hang him.*'" *Verbum sap.*

* In view of these hand-to-hand combats, small hand torpedoes, composed of india-rubber waterproof bags containing gun-cotton (oz.), are designed, with detonators and wires, to be thrown and detonated as hand-grenades.

† It is perfectly possible for a torpedo-launch to leave Portsmouth after dark, and to destroy ironclads inside the breakwater at Cherbourg, and return to Portsmouth before daybreak, without discovery on a dark winter's night, with a *minimum* risk of detection, and without exhibiting its nationality.

II. THE SOUL: WHAT IS IT?

CONCERNING the constitution of man there are three distinct theories. The first regards him as composed simply of a body, actuated for a time either by the ordinary forms of energy or by some modification thereof not yet recognised, and as losing at death his personal individuality. The second and more popular view acknowledges in him a double nature, comprising, in addition to the palpable, ponderable, and visible part or body, an invisible and immaterial principle, known promiscuously as "soul" or "spirit." But there is yet a third theory, which considers man as a threefold being, made up of body, soul, and spirit. It is no part of our present purpose to define the exact sense in which these last two terms are used. It may suffice to say that by the ordinary advocates of the triplicity of human nature the "soul" is supposed to be the purely immaterial element, whilst the "spirit" forms a connecting-link between the two, and, if not purely incorporeal, possesses none of the ordinarily recognised properties of matter.

An author* whose speculations we are about to examine exactly reverses these two terms, and looks upon spirit as a something absolutely immaterial and transcendent, whilst the soul, the seat of the will, the passions, and emotions, is perceptible by one, at least, of our senses, and is even capable of being experimentally isolated and obtained in solution.

We well know that the orthodox method of treating such an announcement is either by contemptuous laughter or by the "conspiracy of silence." We, however, hold that Science has nothing to lose, and may have much to gain, by a dispassionate examination even of the wildest theories. By so doing she will probably fare as well as did the fabled brothers who, in searching for a supposed buried treasure in their estate, marvellously enhanced its fertility.

We find ourselves confronted by a number of facts, hitherto without explanation and without connection. Among these must rank the phenomena of sympathy and antipathy as between different individuals, human or brute. On first meeting with some person of whom we have no previous

* Professor Jäger.

knowledge, we often experience a strong liking or a violent dislike, for neither of which we can render any definite reason. As a rule women and children are more frequently impressed in this manner than are adult men. It very often happens, too, that if we suppress and overcome these sudden prepossessions, we find in the end that they were justifiable, and that second thoughts were not best. What is the key to that strange personal ascendancy which some men seem to possess over their associates? This mastery is not necessarily connected either with physical or intellectual superiority, nor certainly with rank or position. There are characters who are obeyed, even by their official superiors or their employers. There are others who cannot uphold authority over inferiors without incessant punishments.

Further, the emotions and passions of men assembled together are infectious, passing from one to another more rapidly than bodily diseases. From one or from a few energetic individuals enthusiasm may be diffused through a senate, a regiment, or a ship's crew. On the other hand, a few terrified or bewildered persons may spread a panic among thousands. It is commonly said that emotions propagate themselves, but we wish to know in what manner and by what means this is effected.

Again, domestic animals very often display a sympathy for some persons, and a hatred for or a fear of others, which are very hard to explain. We have known men who could approach the most ferocious dog without any fear of injury, whilst others can scarcely walk along a public thoroughfare without being barked at by every cur they meet. Why will a horse obey implicitly one stranger and become unruly and refractory if touched by another? Why will cows or oxen, when driven along a road, make a rush at some one passenger, after letting scores of others go by unharmed? The reasons commonly given for these differences of behaviour will not bear close inspection. Dog-worshippers, forgetting such cases as that of the robber and assassin Peace, insinuate that their pets have an instinctive repugnance for a man of bad character. Others assert that dogs attack only the timid. We knew a gentleman, exceptionally courageous, who was a particular object of the ill-will of these animals. He was often first made aware of the presence of a dog by a volley of yelps and snarls close behind him, so that the attack cannot have been provoked by any demonstration on his part. It is said that animals fawn on such as like them, but flee from, or, if strong enough, attack such as view them

with dislike. We can contradict this assertion from personal experience. We are by no means fond of cats, yet these creatures approach us without hesitation, spring upon our knee, rub their heads against our face, and can scarcely be made to understand that such attentions are far from welcome. A very remarkable fact is the influence which some men possess over horses, and which seems rather a personal peculiarity than any secret that could be communicated to others. It is said that such men have been known completely to subdue a vicious horse by blowing into his nostrils.

We find, again, sympathies, and especially antipathies, which may be traced between entire species of animals, and which some of us seek to explain by the indefinite and long-suffering word "instinctive." If a dog has been stroked with a gloved hand, and if the glove is then held to the nose of a young kitten, still blind, the little creature begins to spit in anger. How is this fact to be explained? The kitten has never yet seen a dog, but by the mere odour it recognises a hostile element. Heredity? True, but how is the antipathy handed down from generation to generation? By what sign does the blind animal detect the presence of an enemy? Very similar is the dread or disgust felt by mice in the neighbourhood of a cat. If one of these animals is kept in a house, no matter how lazy and sleepy she may be, the mice generally withdraw to safer quarters. Shall we suppose that they have all seen or been chased by this enemy, or that those who have fared thus spread the news to their companions?

There is still a further phenomenon which may be looked on as a heightened antipathy—fascination. We all know that very intense fear, instead of prompting to flight, may paralyse. It is said that certain rapacious creatures, especially serpents, have the power of producing in their intended victim a kind of torpor, so that it helplessly and passively awaits certain destruction. We never had the good fortune to witness an incident of this kind, but Knapp, in his "Journal of a Naturalist," gives a case as from his own observation.

We come next to a class of phenomena on which accurate observation and careful experiment are still more needful. It is asserted by popular tradition, and is half admitted by Dr. O. Wendell Holmes, that certain animal secretions if introduced into the body of some other animal, of the same or of a different species, may have a strangely modifying action upon the individual thus inoculated. This is said to

have occurred in cases where the bite of a rattlesnake has not proved mortal.

Taking a general view of all these phenomena, in so far as they are actually established, it would seem that animals, including man, must throw off from their surfaces some emanation capable of acting upon other animals and men with whom they come in contact or in near proximity. This supposed emanation may vary in its character in one and the same individual, according to its psychical condition. If the vapours or gases thus emitted by two animated beings are in harmony, the result is sympathy or attraction. If they disagree, the consequence is antipathy, showing itself as hatred in the strong and as fear in the weak. This, it will be doubtless admitted, is a possible explanation of some of the phenomena above noticed; but is it the true or the only one? Do such emanations really exist? It is, we think, certain that many animals become aware of the presence either of their prey, of an enemy, or of a friend, by the sense of smell, even at very considerable distances. Our lamented friend Thomas Belt was led to the conclusion that ants are able to communicate with each other by means of this sense, and have in fact a smell-language. Unfortunately the sense of smell is so weak in man that it becomes very difficult for us to decide.

Prof. Jäger holds that certain decompositions take place in the animal system in strict accord with psychic changes. All observers, he tells us, agree that muscular exertion effects but a very trifling increase of the nitrogenous compounds present in the urine. On the other hand, Dr. Boecker and Dr. Benecke* have proved that intense pleasurable excitement effects a very notable increase of the nitrogenous products in the urine, derived, as a matter of course, from the decomposition of the albuminioid matter in the system. Prout and Haughton have made a similar observation concerning the effects of alarm and anxiety. Hence, therefore, it would appear that strong emotion involves an extensive decomposition of nitrogenous matter, and in particular of its least stable portion, the albuminous compounds. But does the whole of the matter thus split up reappear in the urine? Prof. Jäger thinks that a portion escapes in a volatile state, forming the odorous emanations above mentioned. This portion he considers is the soul, which exists in a state of combination in the molecule of the albumen, and is liberated under the influence of psychic

* Pathologie des Stoffwechsels.

activity. Hence his soul, like the body, is not a unitary entity, called once for all into existence, but is a something perpetually secreted, and as perpetually given off. It pervades the entire system. Each organ has its distinct psychogen, all of which, however, are merely differentiations of the one primary ovum-psychogen. Further modifications take place from time to time, in accordance with the mental condition of the man or other animal. It will here be remembered that, according to Haeckel ("Die Heutige Entwickelungslehre in Verhältnis zur Gesammt-wissenschaft"), all organic matter, if not matter altogether, is be-souled. Even the "plastidules"—the molecules of protoplasm—possess souls.

In support of the assumption that a volatile something is given off from albumen, Prof. Jäger gives the following delicate experiment:—If we prepare, from the blood or the flesh of any animal, albumen as pure as possible, and free from smell and taste, and treat it with an acid, there appears a volatile matter which is perfectly specific, differing in the case of each animal species. But this odour varies according to the intensity of the chemical action. If this is slight we perceive the specific "bouillon odour" which the flesh of the animal in question gives off on boiling. On the contrary, if the reaction is violent, the odour given off is that of the excrement of the species. Here, then, we have the two main modifications of psychogen, the sympathetic and the antipathetic form.

Dr. O. Schmidt, Professor of Chemistry and Physics at the Veterinary College of Stuttgart, has repeated these experiments upon the brains of animals. The odoriferous principle is here evolved much more easily than from egg albumen. Immediately on the addition of an acid an offensive odour appears, which vanishes as rapidly, and cannot be caused to reappear. Nor has it been found possible to elicit from brain the more agreeable odour.

It will doubtless be granted that certain yet unexamined specific odours are given off by living animals; that these odours may be repulsive or attractive to other species; that they may be liberated more abundantly under mental excitement. But where is the proof that these odours are the soul in any condition? May they not be regarded merely as an effect which psychic emotion, along with other agencies, produces in and upon the body?

We will therefore, though not without misgivings, quote an experiment to which Duntsmaier ataches much importance. He placed in a large wire-work cage a number

of hares, and allowed a dog to run round this prison, snuffing at the inmates, and attempting to get at them for about two hours. It need scarcely be said that the hares were in a state of great terror. At the end of that time the dog was killed; his olfactory nerves and the interior membranes of the nose were taken out with the least possible loss of time, and ground up in glycerin. The clear liquid thus obtained contained the souls of the hares, or at least portions of them, in an intense state of painful excitement. Every animal to whom it was administered, either by the mouth or by injection under the skin, seemed to lose all courage. A cat after taking a dose did not venture to spring upon some mice. A mastiff similarly treated slunk away from the cat. Now we are here confronted by a serious difficulty: if a second dog was rendered timid by merely a small portion of this extract of fear, how is it that the first dog, after snuffing up the whole, did not suffer the same change and become afraid of the hares?

Other experiments, we are told, were tried with analogous results. Thus a glyceric extract of courage was obtained from a young lion, the olfactory nerves of a dog being again used as the collecting medium.

A difficulty which must make us hesitate before ascribing animal antipathies to some disagreement in their souls, making itself known by their specific emanations, is the following: the animals of uninhabited islands when they first come in contact with man entertain no antipathy for him, until his propensity for indiscriminate slaughter is learnt by experience. Can we assume that his emanations have changed in the meantime? Again, a colony of mice had established themselves at the bottom of a deep mine, doubtless in order to prey upon the provisions, candles, &c., of the workmen, and had flourished there for many generations. One of them, being captured, was brought up, placed in a cage, and shown to a cat. The cat prowled around and tried to get at its prey, but the mouse gave not the least sign of alarm. Why should the emanations of a cat be less alarming to this mouse than to any other? Is the tiger, our natural enemy,—which, according to Prof. Jäger, bears the same relation to us which a cat does to a mouse,—any more offensive to us than certain animals which never prey upon man at all, such as the polecat or the skunk? If the timid man tempts the dog or the ox to attack him, on what principle does he diffuse panic among his fellow-men?

In short, Prof. Jäger's theory is beset with many and serious difficulties. Nevertheless, or rather the more we

consider it entitled to a careful examination, both as regards its conclusion and the phenomena upon which it is based; the science of odours has yet to be constituted, and we are convinced that it will amply repay the needful trouble.

One of our author's favourite ideas is that the social split between Jews and Christians, between Aryans and Negroes, &c., depends on the want of harmony in their specific emanations. The conflicting odours of races and nations play a great part in the history of mankind.

III. INTERNAL ENEMIES.

WE hear from time to time eloquent and perhaps overcharged lamentations over the danger to which public health is exposed from the consumption of articles of diet sophisticated with unwholesome ingredients. But we too often forget that we are liable to greater peril from the use of articles which are incapable of adulteration, but which carry in themselves seeds of disease far deadlier and more difficult to overcome than the mineral poisons. These seeds, or germs of disease, as we have ventured to call them, differ widely among themselves. There are, on the one hand, ferments or poisons—organic no doubt, and in all probability organised—which, when introduced into the human body, set up morbid and often fatal action, such as cholera, typhus, typhoid, scarlatina, diphtheria, and many other of the ills that flesh is heir to. But concerning the nature of these germs we are still very much in the dark. We cannot say whether each such disease springs from a distinct class of germs, which, under all circumstances, if only swallowed, inhaled, or otherwise introduced into the body, produce that disease alone and no other; or whether one and the same kind of germs may not, under different conditions, excite affections which we classify as distinct. Thus doubts are, we believe, entertained by eminent medical practitioners whether one identical poison may not occasion, according to circumstances, either scarlatina or diphtheria.

There are, on the other hand, organisms which we may swallow in our food, of a much larger size, and whose action and nature are much better understood. These creatures,

when they enter our stomachs, instead of submitting, as does lifeless matter, to the digestive process, not merely retain their vitality, but undergo their normal development reproduce and multiply, and devour us in an almost litera sense of the word.

Amongst the most dangerous of these parasites is one which has only been known for about thirty years—the *Trichina spiralis*. This pest is at present far from uncommon in the flesh of swine, and now constitutes a very definite danger for the consumers of pork and bacon. It must not be inferred, as it is by many persons, that the *Trichina* suddenly sprang into being about the year 1850 from what was previously lifeless matter. It is perfectly possible that it may have existed in the swine for untold centuries, but that it was not detected and characterised as a distinct parasitic species. It is again conceivable that, though not recently called into existence, it may only of late years have found its way into the body of the pig. Some authorities, indeed, contend that its original home is that animal which Waterton always called the "Hanoverian," *i.e.*, the rat, but which, as it appears to have entered Western Europe from the plains of the Wolga, may claim another nationality. Rats, as is well known, will visit pigsties in the hope of plunder, and may no doubt be occasionally snapped up and devoured by pigs, which are semi-carnivorous animals. Whether every trichinised pig must at some period of his life have devoured a rat, or whether the parasite can be introduced into swine by some other channel, passing for instance from the mother to her young, is not quite decided, though the latter supposition is by no means out of the question.

A young hippopotamus which died in captivity has been found to be infested with *Trichinæ*. Hence the question has been raised whether the rat theory is correct, and whether the Pachydermata as a family may not be the original home of the *Trichinæ*.

It may here be remarked that rats have been gravely recommended as an important article of human food. A writer in a daily paper, not very long ago, gravely declared that the man who died of starvation so long as rats were to be had for nothing deserved severe punishment. How to escape the danger of swallowing *Trichinæ* was a thing not dreamt of in the philosophy of the humane enthusiast.

But *revenons a nos cochons*, if we may so far parody the proverb.

Suppose the *Trichinæ* have safely landed in the stomach of the pig, their career is somewhat remarkable. In the

course of three or four days they find their way into the smaller intestines, where, when met with, it is known as an intestinal trichina. Here the female, which is about 0·04 to 0·10 of an inch in length, produces living young to the number of 500 to 1000 or more, a process which occupies sometimes three weeks, and then dies. The young parasites, which are scarcely one-twentieth of the size of their mother, do not remain where they were born, but perforate the coats of the intestines, and in the space of about six days distribute themselves through the entire body of their host, especially the anterior portion. They seem especially to haunt the muscles which lie between the ribs, and those of the neck, the jaws, and the eyes. When they have found quarters to their satisfaction their wanderings cease, they attain the full stature of their parent, and are now known as muscle-trichinæ. Their development occupies a space of about two weeks. Having thus reached maturity we might expect that their new task would be the perpetuation of their species; but nothing of the sort takes place: each trichina becomes encysted, coiling itself up something after the manner of an ammonite, and covering itself with a calcareous layer or capsule. Here, then, it remains possibly for years, motionless but yet alive. In this state it is found in the flesh of the pig when slaughtered. There are yet two remarkable points to be noticed in connection with trichinised swine. The animals as a rule do not appear to suffer in any marked degree from the presence of these parasites. So much at least may be said, that they do not present a diseased appearance. This circumstance greatly increases the danger of the *Trichinæ* finding their way into human food. If the pigs when thus attacked became sickly, emaciated, &c., buyers and market inspectors might have their suspicions excited. But, save by microscopical examination, there is no certain way of distinguishing the flesh of a trichinised pig from that of one that is perfectly sound. By what we might almost call a Satanic instinct they never attack the heart of their victim, in this respect resembling the ichneumon larvæ, which, while devouring a caterpillar, leave its vitals unattacked.

Let us now suppose that the flesh of a trichinised pig is served up at table, and is eaten by some unfortunate human being. The first step is that the calcareous cyst or capsule is dissolved by the acid juices of the stomach, and its inmate is set at liberty to repeat the career of its parents. But unfortunately its presence in man is always attended with great pain and serious danger, and in the majority of cases with

death. Of course the greater the number of *Trichinæ* swallowed the more violent is the resulting affection. Even on the very day when the fatal morsel has been consumed loss of appetite, nausea, and diarrhœa occcasionally set in, and, as a matter of course, resist all medical treatment.

Sometimes, however, the mischief only makes itself known from about the seventh day to the end of the second or third week. By this time the *Trichinæ* have perforated the intestines, and made their way into the muscular system.

In this second stage of the disease the sufferings of the patient are often extreme. The face takes a peculiarly bloated appearance and the eyelids swell; violent muscular pain sets in; the hands and feet swell; respiration, swallowing, and the movement of the jaws become difficult; and lastly, profuse and exhaustive sweats, and the ordinary symptoms of typhoid fever ensue, with which, indeed, trichinosis is sometimes confounded. After about the fifth week, if the number of parasites introduced into the body is small, they may become encysted as in the pig, when the alarming symptoms gradually disappear, and the patient returns to his ordinary condition. Death, however, is more frequently the result. We should mention that in man, as in swine, the *Trichinæ* never cut short the sufferings of their victim by attacking the heart.

It may, perhaps, be thought that trichinised porkers are very rarely met with. Such is by no means the case. We learn, on good authority, that in North Germany alone 763 pigs, slaughtered between the years 1864 and 1874, have been found suffering from this affection, and that several hundred human beings have died from partaking of their flesh. A single trichinous pig may easily prove fatal to a hundred men. In England the cases of this fearful disease have hitherto been less numerous than in Germany, from a difference in national habits, to which reference will be made below. Still many of our readers may possibly possess slices of a man who died in London, of trichinosis, some ten years ago, and whose muscles, cut into fine sections, have been duly preserved as microscopic objects.

Lately there has been a very serious outbreak of trichinosis on board the reformatory school-ship *Cornwall*, where eighteen decided cases of illness and one death have occurred. On a microscopical examination of the muscles and viscera of the body, *Trichinæ* were distinctly recognised.

In America the evil and its consequences are spreading, and have reached the Pacific Coast, a fatal case having been observed in Oregon. So that trichinised pork and bacon,

and trichinosis in mankind, may now claim their due place among the established ills which we must take into account.

From what has been already said it will doubtless be understood that when a horde of *Trichinæ* have once established themselves in the flesh of some unfortunate man, there is no known method for their expulsion or destruction. There they are and there they must remain, and the physician can do little more than seek to alleviate some of the symptoms, and to keep up the strength of his patient till the intruders pass into the encysted stage and cease to occasion torment.

Hence, as cure is scarcely possible, the more weight must be laid upon prevention, and this fortunately is quite within human reach. The most highly trichinised pork may be eaten with safety if every part of it has been exposed, for a sufficient length of time, to a temperature of not less than 212° F. Indeed the *Trichinæ* are found to be killed at much lower temperatures, even at 134° to 140° F. But in practice the difficulty lies here,—that though a sufficient temperature may be reached on the outside of a large piece of meat, yet, on account of the very defective conducting-power of the material, the heat at a little distance from the surface falls far short of the mark. Boiling for two hours is not more than sufficient to produce a temperature of 140° F. at the depth of 2 inches from the surface. Dr. Gerlach boiled a piece of meat 4 inches in thickness for an hour, and at the end of that time he was able to find *Trichinæ* still living in the interior! Roasting is still less efficacious, as the brown outer layer is a yet worse conductor of heat than the meat in its original condition. Dr. Dietzsch, chemist to the Industrial Museum of Zurich, lays down the rule that so far as boiled or roast meat has a reddish colour, or emits a reddish juice when cut, the *Trichinæ*, if present, will still be living.

Everyone therefore must admit that the process of cooking, so called, as it is carried on in most hotels, restaurants, coffee-houses, &c., in the "'am and beef-shops" of London, and even in many private families, is no safeguard whatever. If *Trichinæ* were found in the meat as it left the butcher's shop, they will still be found in the half-raw mass served up at table. The only method for the effectual destruction of these and other parasites would be to abandon our old semi-barbarous habit of cooking meat in such huge masses that the outside may be charred whilst the "unknown interior" is still raw. The admirers of such crude matter —"rare" they call it—can scarcely now plead superior

wholesomeness for the disgusting condition in which they expect joints to be served up.

But if we in England submit our animal food to a mere nominal cooking, some of our Continental neighbours go a step further, and omit the process altogether. In Switzerland, Germany, and we believe in Holland, ham, bacon, sausages, and what is called "hack fleisch" (*i.e.*, meat chopped up as if for sausages, but not put into a skin), are consumed positively raw. This is the reason why deaths from trichinosis are more plentiful in Central Europe than in England or France, and why in Germany every pig slaughtered—or, we presume, imported as dead meat—is subject to an official microscopic examination before it may be lawfully offered for sale. This must be pronounced a very judicious regulation so long as any portion of swine's flesh is to be consumed in a raw or a half-raw condition. Uncooked sausages are exceptionally dangerous, because they are often made from those portions of meat which lie nearest to the bones and the tendons, *i.e.*, precisely the parts where the *Trichinæ* are most apt to take up their abode.

Not a few persons entertain the superstition—we can give it no better name—that smoking hams or bacon will kill *Trichinæ*, if present, and will altogether act as a substitute for cooking. It is possible that if creosote, the supposed active ingredient in wood-smoke, were placed in a concentrated state in actual contact with a *Trichina* that the life of the parasite would be cut short; but even if the outside of a ham is painted over with a solution of creosote the interior offers a safe shelter. Long before the *Trichinæ* were all killed the ham would be rendered utterly unfit for food.

Thorough drying, without any attempt at smoking, is fatal to *Trichinæ* as far as its action penetrates; but a little reflection will show us that this process can rarely penetrate much below the surface, and must be utterly ineffectual as far as the centre of a ham is concerned.

Very similar is the action of salting. The *Trichinæ* die near the surface, but to kill them throughout would require such a proportion of salt that the meat could not be eaten. After a week's exposure to brine living *Trichinæ* were found by Dietzsch at an inch from the surface.

The microscopic detection of *Trichinæ* is fortunately not a difficult task. Dietzsch directs that thin portions of the flesh, not larger than a pin's head, should be cut with a sharp razor in a direction parallel with the fibres. It is placed on a slip of glass, teased out a little with the needles,

moistened with a drop of glycerin or water, and examined with a magnifying power of from 50 to 100 diameters. If no *Trichinæ* are visible, it is prudent to re-examine after moistening the specimen with a single drop of the solution of potassa (1 part in 15 parts of water), when the muscular fibre becomes transparent, and the *Trichinæ*, if present, are brought into full view. It is important, in making the examination, to select the sections from those parts where *Trichinæ* most do congregate,—*e.g.*, from the sinewy ends of the muscles, especially those of the eyes, the jaws, the neck, &c.

We are well aware that the existence of *Trichinæ* and other parasites is urged by the Vegetarians as a powerful argument against the use of animal food. Strange to say, however, like many other reformers, they indulge at times in a little inconsistency. They extend to milk an exceptional toleration. Now milk, to the best of our knowledge, never contains *Trichinæ*, but if drawn from a cow affected with tuberculosis—no very rare occurrence—it is able, as has been experimentally proved, to set up tubercular disease in animals by which it is consumed. This dangerous property, moreover, is not in the least removed by boiling. So that Vegetarianism, as generally preached and practised, is no safeguard.

IV. THE ANTIQUITY OF MANKIND.*

WHILST the first appearance of human life upon the globe has risen almost to the rank of a "burning question," no small share of its attraction and of the attention which it receives are derived, singularly enough, from an extraneous and even an illegitimate, source. The true man of Science, whilst eager to learn the exact truth on this subject, is utterly indifferent what that truth may be. Prove to him that our forefathers have lived and suffered and died upon this planet for seven million, or merely for some seven thousand years, and he will listen

* Early Man in Britain, and his Place in the Tertiary Period. By W. Boyd Dawkins, F.R.S., &c. London: Macmillan and Co.

Fossil Men and their Modern Representatives. By J. W. Dawson, F.R.S., &c. London: Hodder and Stoughton.

with judicial impartiality. In neither case are his hopes or his fears called into play any more than on learning the exact composition of a mineral, the locality of a plant, or the structural peculiarities of a caterpillar.

Unfortunately, however, two numerous and active sections of the public approach this question not with the feelings of a judge, but with those of an impassioned and unscrupulous advocate. Though respectively hostile, they have both been mistrained into a common error. Both conceive that the interests of revealed Religion are gravely compromised if it should appear that mankind came into being earlier than the "4004 years before the vulgar Christian era," as assumed by Archbishop Usher. Guided by this erroneous principle, Secularists and Materialists are eager to admit, and, on the other hand, orthodox theologians are no less anxious to deny, the high antiquity which has lately been assigned to our race. How utterly unfit such frames of mind are for the quest after truth, and how greatly the final solution of the difficulty must be hindered by such feelings, needs no demonstration. The position of those who, like ourselves, are determined to judge this question from a purely scientific point of view, craving neither to confirm nor to infirm any theological doctrines, and holding fast to the great principle of Galileo so often enforced in the "Journal of Science," is rendered peculiarly difficult. Each party confounds us with its opponents.

One of the works which have led to our selecting this subject is written in the very spirit which we are endeavouring to recommend. Mr. Dawkins writes not to uphold any foregone conclusion. He examines the evidence in favour of the pre-historical, and even pre-mythical, existence of man impartially, critically, even sceptically, just as he would deal with the facts advanced to show the presence of any particular animal or vegetable form at some given geological epoch. It is naturally impossible to treat such a subject in an intelligible manner without giving a general survey of past geological changes and of the three great phases of organic life upon the earth. In the course of this sketch the author declares himself an Evolutionist. He declares "the argument in favour of the theory of Evolution founded on the specialisation of mammalian life in its progress from the Eocene times down to the present day seems to me so strong as to be almost irresistible." In a diagram he shows that in the Eocene there appear families and orders which have still their living representatives, but none of the present genera. In the Miocene, a step nearer

in point of time brings us also a step nearer in point of development, as we now find not merely orders and families, but genera which still exist. We pass on again to the Pleiocene, and here we have even living species, though few in number, and accompanied by a majority of extinct species. In the Pleistocene, again, we find living species now no longer few, but numerous, whilst the proportion of extinct species has decreased. In the Prehistoric we see—as far as Europe is concerned—living species accompanied by one only extinct form.

These remarks and this diagram are not given by the author as a biological confession of faith; they are the summary of certain phenomena which bear closely upon the question at issue. Was man found in Britain or in the world in the Eocene epoch? We look over the mammalian remains of those days, and we certainly find members of the order Primates, to which man belongs; but they are exclusively lemurs, members of the order lowest in their structure, and most remote from man and from the anthropoid apes. None of them, further, belong to any existing genus. The lemurs of those days were still closely linked to the Ungulates, or hoofed quadrupeds, and the beasts of prey bear a marsupial stamp. Surely, then, in the absence of any direct trace of man or of his works, we are warranted in concluding, with the author, that in such a fauna man could find no place. To seek for so highly specialised a being as man "where no now living genus of placental mammal was present would be an idle and hopeless quest."

We come next to the Meiocene Age. Mr. Dawkins describes the climate, the fauna, and the flora, and admits that the climate was favourable and that food was most abundant. Further, representatives of the higher apes were now present in Central and Southern Europe. Still the Meiocene fauna affords not even a single instance of any land mammal which still survives. Is it, then, probable that man, "the most highly specialised of all creatures, had his place in a fauna which is conspicuous by the absence of all the Mammalia now associated with him?" "If," the author adds, "we accept the evidence advanced in favour of Meiocene man, it is incredible that he alone, of all the Mammalia living in those times in Europe, should not have perished or changed into some other form in the long lapse of ages during which many Meiocene genera and all the Meiocene species have become extinct. Those who believe in the doctrine of Evolution will see the full force of this argument against the presence of man in the

Meiocene fauna, not merely of Europe, but of the whole world."

This argument, in the absence of direct evidence of the existence of man in the Meiocene epoch, seems incontrovertible. It will be at once, however, perceived that—however conclusive against the presence of man, in the strictest sense of the term—it does not disprove the existence of beings somewhat closely approaching him. Dr. Hamy, M. De Mortillet, and others assert, indeed, that man inhabited France in the middle of the Meiocene epoch. Splinters of flint and the notched rib of an extinct manatee (*Halitherium* have been found in Meiocene deposits. Granting that such deposits had been undisturbed, the author and Prof. Gandry venture to ask whether these relics can have been the work of the *Dryopithecus*, a huge extinct anthropoid ape, rather than of man. No present apes are known to use stones except for nut-cracking. But Mr. Dawkins thinks it not improbable that some of the extinct higher apes may have possessed qualities not now found in their living successors. We must remember that the doctrine of Evolution nowise supposes an universal advance throughout the animal kingdom. There is nothing absurd or contradictory in the supposition that some species little inferior to man, or to the direct ancestors of man, may have become extinct.

In the Pleiocene age the improbability of the existence of man is greatly lessened. Not merely genera, but in any case one mammalian species is found to have survived down to our own days. But unfortunately, in these very formations, we have one of the most annoying instances of the "imperfections of the geological record." In Britain, at least, the strata of this epoch are either marine or have been subjected to the action of the sea. In France and Italy, however, we find marmots, elephants, oxen, and dogs making their first appearance in the world. Still Mr. Dawkins, from considerations very similar to those advanced as regards former epochs, considers the advent of man in the Pleiocene as highly doubtful. Of twenty-one fossil Mammalia proved to have inhabited Tuscany in this Age, one only, the hippopotamus, still survives on this earth. Nor is there any decided affirmative evidence to overweigh this improbability.

In the next following, or Pleistocene epoch, the case is altered. We are now introduced to mammalian forms still inhabiting the earth. Though the mammoth, the cave-bear, the Irish elk, and the sabre-toothed tiger still survived, such well-known modern species as the shrew, the mole, the

beaver, wolf, fox, stag, roe, the wild bull (*Urus*), the wild boar, and the horse have made their appearance. Still the proof in favour of man's presence, in Europe at least, in the early Pleistocene is not free from doubt, and the author agrees with Sir John Lubbock in referring the evidence to a "suspense account." In the middle Pleistocene man existed in Britain, as is proved by a wrought flint-flake found by the Rev. Osmond Fisher, in the author's presence, in the lower brick-earths at Crayford. Mr. Dawkins guarantees that it was *in situ*. Four years later a second specimen, also *in situ*, was found in the same series of beds at Erith. The discovery of these two implements shows that man lived "in the valley of the lower Thames before the Arctic Mammalia had taken full possession of the Thames Valley, and before the big-nosed rhinoceros had become extinct." Among his animal neighbours were grisly bears, enormous lions, hyenas, and wolves. Against these formidable competitors the "river-drift men" had to struggle, armed with but poor appliances. Flakes of flint, quartzite, or chert, roughly chipped to a cutting edge, served them for tools and weapons,—a slight advance beyond the condition of the ape who employs unsharpened stones to break nuts or to pound the head of a venomous serpent.

It may be well here to mention that Mr. Dawkins is by no means hasty in accepting evidences of the existence of pre-historic men. Professors Rütimeyer and Schwendauer, for instance, had detected in the lignite beds of Dürnten and Ultznach, of the Mid Pleistocene Age, a something which seemed to be the fragmentary remains of fossilised basket-work. Our author, however, after examining these relics, views them as knots from a decayed fir tree, without any marks of human handiwork.

As we descend to the later Pleistocene Age the signs of man's presence and activity become more numerous. The valley of the Thames and the fluviatile gravels of Salisbury, and a variety of spots in the south-eastern parts of England, have yielded rude stone-implements of the type generally known as palæolithic. Nothing similar has, however, yet been found to the north-west of a line drawn from Bristol to the Wash. On what is now the Continent these same palæolithic men appear to have been widely, though not thickly, spread. In France, Spain, Italy, the north of Africa, Syria, and India, traces of their former occurrence are found in the shape of stone-implements of the same type. Skeletons of these river-drift men have also been discovered, though in so very fragmentary and imperfect a

state that no very precise idea of their physique can be formed. Mr. Dawkins, however, considers that at this Age, remote as it is, man was present in Europe as such, *i.e.*, in a form not widely differing from those of more recent days. Hence it is plain that the intermediate forms, connecting man with the lower anthropoids, must be sought for in the early Pleistocene, and possibly in the Pleiocene, formations. These pristine men, however, if sufficiently distinct from any known ape, fossil or living, are no less incapable of being identified with any human type now existing. They must doubtless be considered as the undifferentiated stock from which the various races of mankind have branched out. One interesting question remains: What was the relation of these earlier men to that mysterious phenomenon, the Glacial epoch? Mr. Dawkins concludes that in the milder regions of Europe man was probably not merely glacial, but even pre-glacial. He only penetrated, however, to the north of the Thames when that evil period had come to its end.

Formations of a later date reveal to us the footsteps of a different and a higher race, the so-called cave-dwellers. Both in Britain and in France the river-drift men were followed by population much less widely distributed, who may be identified with the Eskimos of the Labrador and the extreme north of America. Among their relics there occur stone tools and weapons of a much more perfect kind than those used by the river-drift men. We find arrow-heads, harpoons, saws, and borers. The first attempts at decorative art have even made their appearance. Bones and teeth have been discovered engraved with representations—rude, but capable of recognition—of hunting-scenes. Clothing and personal ornaments had also made their appearance. These cave-men, however, who must be distinguished from their neolithic followers as well as from their predecessors, the river-drift men, were not in possession of the art of pottery; they did not bury or otherwise dispose of the remains of the dead, and they had not domesticated the dog. It must here be remarked that in every case the lower civilisation preceded the higher. Mr. Dawkins considers that the river-drift men had probably lived for countless ages in Europe before the arrival of the cave-men. The Pleistocene Age, it must be remembered, was of vast length.

We are now landed in that somewhat indefinite epoch known as the pre-historical, where the climatic conditions, the fauna, and the flora of Europe, no longer show any marked diversity from what obtain at the present day. Here the subject gradually passes from the jurisdiction of the

geologist and the biologist to that of the antiquary, the interpreter of sagas, and the historian.

Now, therefore, whilst regretting that we can no further accompany Mr. Boyd Dawkins in his interesting survey, we may fitly record our opinion of the manner in which he has executed his task. It has rarely been our good fortune to meet so difficult a question treated with such indisputable acuteness, breadth of view, learning, and impartiality. Rash credulity and equally rash scepticism are equally avoided, and the result is a manual which the student and the cultured man of the world may each take up with full assurance that he will not be led astray.

The other work which we have coupled with that of Mr. Dawkins is one of a diametrically opposite character. Professor Dawson, at the very outset of his work, gives no doubtful sound. He utters his accustomed defiance to Evolutionists; he takes care to assert his belief in the absolute distinction between man and the lower animals, above all; he claims for the Hebrew Scriptures, by implication at least, the character of a physical revelation, thus perpetuating that wholly gratuitous warfare between Religion and Science which less prejudiced minds are seeking to abolish. Finally, he ascribes to the human race an existence not dating farther back than from 6000 to 8000 years. In other words, he starts with the assumption that traditional chronology is correct, and then strains all the powers of his mind, and applies all the resources of his extensive learning, to interpret facts so as to harmonise with this foregone conclusion. This procedure is, we maintain, fundamentally illegitimate. The man who really writes, as Prof. Dawson claims to do, "from the point of view of the geologist and naturalist," sees in traditions and cosmogonies merely a reflection of the beliefs current in early times, and starting from the facts he seeks for them the most rational interpretation. In the work before us every fact that tells for the long duration of the human race is questioned, and, if not denied, explained away. Because men in a certain low stage of civilisation were found in Canada and Newfoundland, by Jacques Cartier, in 1534, we are asked to believe that the drift-men and cave-men of Europe have not long disappeared from the globe! With every respect for Prof. Dawson as an indefatigable and successful collector of facts, we cannot accept as a guide in generalisation one who shows so strong a bias and so strong a determination to be guided by what we can only regard as perfectly foreign considerations.

ON WATER AND AIR.*

By JOHN TYNDALL, D.C.L., LL.D., F.R.S.,

Professor of Natural Philosophy at the Royal Institution of Great Britain.

LECTURE V.

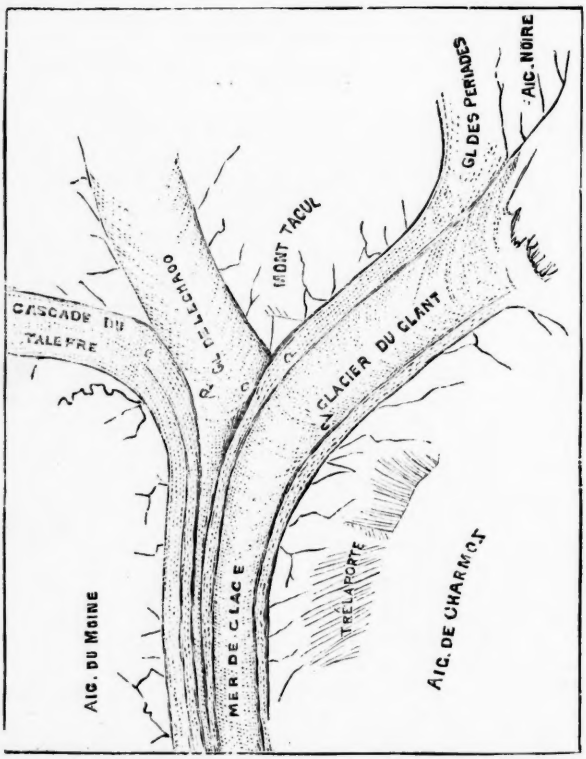
I TRUST that you already know as well as I do that the vapour of the ocean is raised by the sun into the atmosphere, and that when chilled it becomes precipitated as cloud, and that when the chilling goes far enough it is precipitated as snow. One sample of cloud manufacture I should like to bring to your attention, because it is a very interesting one; and I should like you when you go to the Alps in future years, as I have no doubt many of you will, to be able to notice this phenomenon, and also to understand its nature. You sometimes find a perfectly transparent air charged with aqueous vapour in the true invisible vaporous condition, blowing against a cold mountain-crest. On the side of the mountain upon which this air impinges all is perfectly clear and bright, but on the other side of the mountain you have a vast cloud banner drawn out, which is the aqueous vapour of this perfectly transparent air precipitated into cloud by the cold crest of the mountain. I have seen it on many peaks frequently. On the Matterhorn, for instance, the air charged with aqueous vapour comes up from the plains of Italy; meeting with the mountain-crest it is chilled, and condenses on the farther side of the mountain, forming a large streaming cloud, which appears to be attached to the summit of the peak, with perfect steadiness, in spite of the strong wind that is blowing. This steadiness, however, is only in appearance, the cloud being constantly dissipated at its farther extremity, but as constantly renewed by the continuous supply of warm moist air which gives rise to it.

We have now to consider the subject of the formation of glaciers, and as an example of a simple glacier will take the

* Being a Course of Six Lectures adapted to a Juvenile Auditory, delivered at the Royal Institution of Great Britain, Christmas, 1879. Specially reported for "The Journal of Science."

celebrated Mer de Glace, of Chamounix. It is not by any means the largest glacier in Switzerland, but historically it is very celebrated. Here is a sketch map (Fig. 30) of the Mer de Glace, with its tributary glaciers. Now the vast gathering ground of snow which forms these glaciers is

FIG. 30.



marked here: one is the great basin surrounded by lofty mountains, called the basin of the Talèfre; here a second one, called the plateau of the Col de Lecleand; and here another great gathering ground is in the region of the Col du Géant. This great basin is where the snows collect and contribute to the formation of the great glacier.

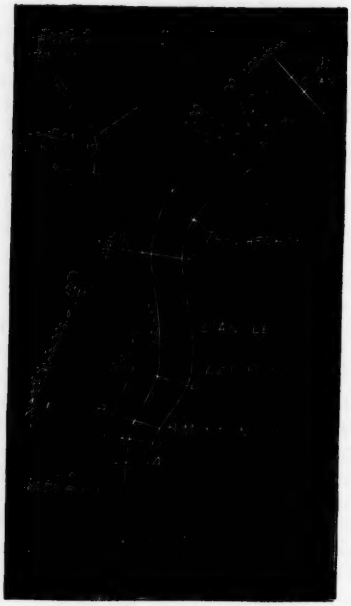
If I were to take a quantity of snow and subject it to pressure I should compress this snow into solid ice. Now the mountains surrounding this region are continually discharging their snows upon these great plateaux, and this continuous accumulation compresses the snow into solid ice; and rigid as this ice seems it is always moving downwards. It moves down almost like water, and fills the valley of the Col du Géant, forming the glacier of that name. This glacier is joined by another called the Glacier de Lechaud; and here another glacier comes down, falling apparently in broken fragments, in a kind of cascade, which is called the Cascade du Talèfre; and these three glaciers unite and form the celebrated Mer de Glace. You observe here the extraordinary fact that these great and wide glaciers squeeze themselves down through this narrow valley of the Mer de Glace at Trélaporte, as if the ice in point of fact were water. The quantity of squeezing endured at this place called Trélaporte is very great. The glacier coming down from the Col du Géant is 1134 yards across; the one from the Jorasse, the Glacier de Lechaud, is 825 yards across. The glacier coming down from the Talèfre is, at a certain place near the cascade, 638 yards across, and the sum of these three glaciers amounts to 2597 yards in width. All these three are squeezed together through that defile at Trélaporte, which is only 893 yards wide. This gives you an idea of the tremendous power with which these ice-masses are forced forward in order to form these glaciers. I say forced forward, and that implies, of course, that the glaciers are always in motion; and this is the case winter and summer. The summer motion of this Mer de Glace amounts to a certain number of inches per day; the winter motion is about half the amount. The summer motion is on the average about 30 inches a day; the winter motion is about 15 inches a day, the ice being more rigid and less yielding in winter than in summer.

You see the motion of the ice through this valley; it twists round and turns, and imitates, in all its movements, the motion of a river. Many distinguished men have worked at these glaciers, but perhaps none have contributed more to our knowledge of the matter than two men who are now no more—the celebrated Agassiz, who died some time ago in America, and the celebrated Principal Forbes of St. Andrews.

Here is a rough diagram of the Mer de Glace with certain lines drawn across it (Fig. 31). The velocity of the glacier where those lines are drawn has been determined. I will

run briefly over the maximum, or what I call the greatest motion of the glacier. That motion is not always at the middle of the glacier, but near the middle, for the glacier in this respect resembles a river. Owing to the friction of the sides on the banks of the river, the water is held back, so that the place of maximum motion of a river is near the centre. Across the line A A′ the maximum motion is about 33 inches in 24 hours; across the line B B′ it is about 24 inches in 24 hours; across the line C C′ it is about

FIG. 31.



34 inches in 24 hours; across the line D D′ it is about 23 inches in 24 hours; across the line E E′ its maximum motion is about 20 inches in 24 hours. Also with the tributary glaciers the maximum motion across the line H H′, on the Glacier du Géant, is 13 inches in 24 hours. The maximum motion across the line K K′, on the Glacier de Lechaud, is 10 inches in 24 hours. Thus you see the velocity of the glacier changes. As I have said, the motion of a glacier resembles perfectly the motion of a river, in that

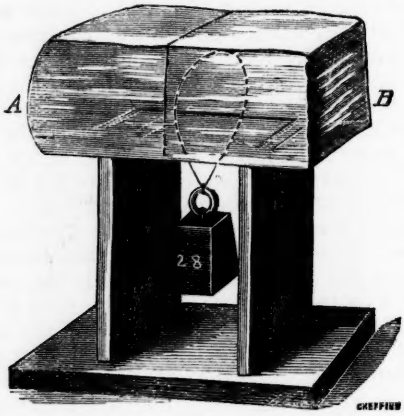
its motion augments from the banks to the centre, because at the centre it is free from the friction of the banks. Take the case of a river which flows through a sinuous valley. Suppose it to be coming down with considerable power, and having to make a bend. The most wondrous example of that kind in the world is perhaps the so-called whirlpool below the Falls of Niagara. There the River Niagara takes a sudden bend at right angles to its previous direction. The water comes down plunging with impetuous force, and impinges against the bank on the other side. It is thus caused to turn round and produce the wondrous whirlpool from which the water escapes on to Lake Ontario. But it is no matter how small the bend may be. The least bending, such as we see here exhibited in the Mer de Glace, has this effect in the case of a river. When the water moves downwards it is always carried on towards the concave bank of the river; and if the river bends in the other direction the greatest motion of the river will not follow the middle line, but will change in accordance with the flexures of the valley through which the river passes. This is the law of the motion of water; the law of the motion of ice is precisely similar. For instance, the continuous line X Y in the diagram (Fig. 31) represents the centre of the glacier. The dotted line marks the maximum motion of the glacier; so you see that the swiftest motion is, as I have said, towards the concave side of the glacier. At Trélaporte the swiftest point is towards E on the line E E'. Then you have a point where the greatest motion coincides exactly with the middle of the glacier; then we come lower down, and here the point of greatest motion passes to the other side of the centre, and is towards D on the line D D'; and then afterwards it passes back again across the centre of the glacier, and its greatest motion is at C on the line C C'. Thus, as I have said, the motion of the glacier downwards resembles in every particular the motion of a river.

Let us turn again to our map (Fig. 30), and mark the wonderful power of the ice to mould itself to the valley through which it presses. See the extraordinary behaviour of the glacier in coming down that valley; and how the ice can accommodate itself to the flexures of the valley; and how the immense masses of ice which are tributaries of the Mer de Glace (the Cascade du Talèfre, the Glacier du Géant, the Glacier de Lechaud) weld together, and squeeze themselves into the extraordinary small space we find at the gorge at Trélaporte. Now it is possible for ice to be squeezed in this way, changing its form but not its volume, and

appearing after the change as solid and as homogeneous as before.

A curious phenomenon was first observed by Faraday, who found that when two pieces of ice with moistened surfaces were placed in contact, they became cemented together by the freezing of a film of water between them. I have here two slabs of ice, the surfaces of which I will press together, and you see I have frozen the two slabs into one mass. Prof. Bottomley made an experiment recently which bears upon the subject. It is there in action before you. Upon the two uprights (Fig. 32) is placed a large block of clear ice (A B) with a loop of wire round it: twelve hours

FIG. 32.



ago a 28 lbs. weight was attached to the wire. The wire immediately commenced to enter the ice, and you see by this time it has passed half-way through it, but the ice has remained undivided: except for a little opacity along the plane of passage, it shows no signs of ever having been divided. If we allow it to go on it will pass right through the ice, the severed surfaces re-freezing, and leaving the block entire as at the commencement.

I have here a number of moulds of different shapes, and if time permitted I could have shown you that by filling them with fragments of ice, and subjecting the ice to pressure, I could have moulded these fragments into cups, spheres, vases, &c., of solid ice; so by these illustrations you can readily understand how a substance which so readily

changes its form under pressure, and so readily unites when broken, can be forced through narrow gorges, and can accommodate itself to the bendings of the valley through which it moves.

And now we have to dwell a little upon certain phenomena connected with this motion. And, first of all, with regard to these curious masses which are heaped up sometimes upon the glacier and sometimes at the side of the glacier, to which the name of "moraines" is given. You cannot have a better example of the origin of these moraines than you have here upon this Mer de Glace. The mountains bounding the glaciers are incessantly sending down stones and *débris* of all kinds which have been loosened by the frost or by the rain. These tumble down upon the sides of the glacier, and form what is called "lateral moraines." You sometimes find great heaps of matter thrown from the mountains, and the quantity depends upon the friability of the mountains. You find these great masses of stones and *débris* thrown down along the edges of the glacier. Well, now what follows? I will carry you up to that rock which is called the Grand Rognon, which is associated with the Glacier du Géant. You must imagine the surface of that Grand Rognon covered with this *débris*, which has fallen from this rock upon the ice. That ice is for ever moving forwards, and what occurs? Here, at the end of the Grand Rognon, you have a ridge of *débris* carried down by the moving ice, and you can trace it all along the Glacier du Géant down to Trélaporte. We have it marked *b* on the map (Fig. 30). Again, another moraine starts from a point of the Aiguille Noire (it is marked c on the map), and, coming down through the Glacier du Géant, you can trace it through the Mer de Glace. Another starts from that cascade just upon the Telèfre, and you can see it come down there. And when these moraines unite together upon the trunk glacier they form these lines (*e*, *d*, *e*) that you see here, not on the side, but in the middle of the glacier, and hence they are called "medial moraines," so that the side moraines of the tributary glaciers are converted into the medial moraines of the trunk glacier. A moment's reflection will make it clear to you that the number of medial moraines on the trunk glacier must be one less than the number of lateral moraines on the tributaries. Two lateral moraines form one medial moraine, three form two, four form three, and so on.

Well, so much for these moraines. When you come to visit the glaciers themselves, you may look down from a

height upon a glacier and see these moraines perhaps like tracks or roads, in point of fact, coming down along the banks of the glaciers; but when you come to examine them you will find that they are very different from what they appear to be. These moraines rise sometimes to a height of 50 or 60 feet above the level of the glacier. Looking at them you would imagine them to be heaps of stone and clay and dirt that have been brought together—a ridge of this *débris* heaped upon the glacier; but when you come to examine them more closely you find that there is simply a superficial covering of *débris* with a ridge of ice underneath. What is the reason of this? You will understand me immediately. Conceive the glacier covered with this *débris*. It is thereby protected from the melting action of the sun.

FIG. 33

The sun is free to play upon the ice right and left of the moraine, which it melts, and the consequence is that the protected part—that part on which the *débris* rests—is not melted, but remains as a great ridge of ice. In the same way are formed the glacier tables, as they are called. You sometimes find upon the glaciers rocks lifted up as if they had grown, as it were, out of the heart of the glacier: these are due entirely to an action of the same kind. There (Fig. 33) is the glacier table upon a surrounding of ice. That rock was thrown from the adjacent mountains upon the glacier, and has protected the ice beneath. The ice all round this protected ice melted, and by-and-bye this rock

appeared to rise more and more, and finally you find it there as a so-called glacial table. It is not due to the lifting of the table or to the lifting of the rock, but to the melting of the unprotected ice all round the rock.

There are other cases in which protection sometimes comes into play in an extraordinary fashion, and there is nothing more interesting or more striking than what are called the sand cones of the glaciers. Rivers coming near moraines contract a certain amount of impurity, and carry sand along with them and distribute it over the ice; and the ice protected by this sand rises not in reality, but relatively. The surrounding ice is melted away, and these patches of sand appear to rise up, and you have upon the glaciers little mountains—little sand cones as they are called—which might be considered to be representative of the Alps themselves in miniature.

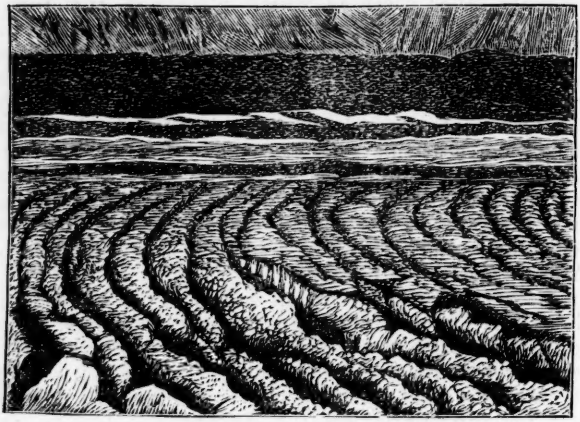
I now want to show you what occurs in consequence of the incessant action of the sun upon the glaciers. The rising of the moraines and the rising of the glacier tables prove that when the sun acts upon the glaciers it rapidly melts the ice. And what is the consequence? Rivers, rivulets, and streams, of great power and impetuosity, are sometimes formed in the glaciers upon those portions which are not very much crevassed (or cut across by open chasms in the ice). Those rivers which come upon a crevassed portion of a glacier plunge into the crevasses or chasms, and find their way to the bottom of the glacier and roll along the bottom as a sub-glacial river underneath the ice, and finally they issue as a river from a vault of ice at the end of the glacier. At the end of the Mer de Glace is a vault of this kind, which in the summer time is exceedingly dangerous to enter. I remember once standing and looking into that vault, and thinking whether I should go into it, it was of such magical beauty; and while I stood pondering upon the point of the prudence and possibility of entering it, the whole roof, weighing some 20 or 30 tons, fell down upon the bottom. In winter it is firm and fast, and can be safely entered and explored.

As I have said, from the termination or snout of the glaciers a river issues, the Mer de Glace being the source of the Arveiron, the Rhone glacier giving birth to the River Rhone, and the sources of the greatest rivers in Europe can all be traced back to the glaciers.

I have said that the centre of the glacier moves more rapidly than the sides, and I have referred to the crevasses, as they are called. That is the technical name

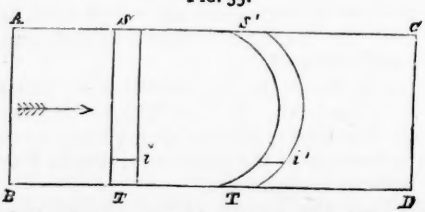
for those great chasms which are sometimes very deep indeed. Now I want to propose a problem to you. There is a drawing of a glacier (Fig. 34), and you observe that black

FIG. 34.



mark on the farther side. That is a great moraine of the glacier cutting off the opposite side of the mountain. Now I want you to look at the glacier itself, and I hope you will answer the question that I shall propose. You see the crevasses sweep round in this way to form curves. I will ask the boys present to answer a question. The glacier runs along there. Will anybody tell me what is the direction in which the glacier is moving? Is it to the right or to the left? [Voices: "To the left."] I venture to say that we shall have in this assembly a majority of ten to one among the boys saying that that glacier moves to the right. It is as if the centre of the glacier pushed the ice forward, and the

FIG. 35.



sides held it back. You will now see that the answer which has been given is precisely the reverse of the truth. I

trust by means of the diagram (Fig. 35) to make the explanation evident to you. Let A C D B be a portion of the glacier, and, for the sake of simplicity, suppose the glacier flowing in the direction of the arrow. Suppose we take a transverse slice of the glacier (s T) and fix our attention upon a little square (T *i*) of this slice, that is a little square mass of ice, and I would ask the boys whether that slice of ice will remain straight after it has been two or three days subjected to the motion of the glacier. (Voices: No.) It will become curved, will it not (as at s′ T) ? The centre will move forward because of the quicker flow of the centre of the glacier; and therefore when that slice of ice (T *i*) comes down we shall have it transformed into the shape T *i*′, and our little square will be distorted to the shape which, as my young mathematical friends know, has usually applied to it the term rhombus, or lozenge. Now I want you to realise the exact mechanical state of matters. When the square (T *i*) is distorted to the shape of the lozenge (T *i*′) the diagonal T *i* of the square becomes the diagonal T *i*′ of the lozenge, the diagonal of the lozenge being longer than the diagonal of the square. If the ice could freely stretch like treacle, one diagonal would stretch to the same length as the other, but the ice does not stretch in that way. It is strained, and it breaks across at right angles to the line of strain T *i*′, and forms a crevasse, or chasm, which, instead of being pointed downwards is pointed upwards, and thus you see that the motion of the glacier is exactly the reverse of what you supposed it to be.

Now I have to point out to you a few examples of violent crevassing. You have seen the real mechanical origin of those crevasses. They are due to the strain imposed upon the glacier by the different motions of its parts. When the crevassing is very violent, and when the glacier is pulled in different directions, you have the crevass converted into the most fantastic peaks and towers of ice. You hear these called in Chamouni and elsewhere *aiguilles* (needles). Now we pass on to a final result of the glaciers. There is the glacier opposite which I spend a couple of months of each year of my life—the great Aletch Glacier—and at a certain place that glacier at one period of its history turned down a lateral valley. It now only fills the great trunk valley. The glacier has retreated from this lateral valley, and in its place we have a little lake called the Margelin See, one of the most picturesque parts of the Alps, and upon this lake you have floating little blocks of ice which are rendered by the snow quite white; and they are, to all

intents and purposes, icebergs. The glaciers of Greenland work their way down into the real ocean, and the ends of these glaciers breaking away in large masses are sent floating out to sea; and it is these icebergs which constitute some of the dangers of the Northern Atlantic. It was one of these with which a vessel came into collision some time ago. That iceberg against which the vessel impinged came from one of these northern glaciers. It was a bit of one of these northern glaciers, broken off and sent into the ocean like the small masses of ice from the Swiss glaciers carried into the Margelin See.

Now I must give a wrench to this topic, and pass on to another subject.

We have to consider this atmosphere, and the physical properties of the air which, in the long run, has sustained the weight of all our glaciers and of all our rivers. It is a constantly observed fact that when there is a great advance in science there is always a general simmering and fermentation of scientific thought for some time previously, and by-and-bye some particular individuals rise, so to say, out of this general fermentation, and initiate the real principle or law, or whatever it may be, about which people are thinking during this intellectual simmering. And so it was some three hundred years ago with regard to our atmosphere. People did not know that the atmosphere had weight. It was shrewdly suspected, however, by that great man, Galileo, and by Descartes, that the atmosphere had weight. But this was not clearly made out even in their day, and when we consider the knowledge that is now open to every little boy and girl it is strange that this knowledge was held back from those truly great men of antiquity, men of the very greatest intellects. We have now to deal with results which they would have given anything to know, and which are now perfectly familiar to us. Descartes realised that the air has weight. The weight of the air in this room in which you are now assembled—what would you guess it to amount to? Perhaps you would say that it weighed a few pounds; but the weight of 13 cubic feet of air is about a pound. There are perhaps nearly 80,000 cubic feet of air in this room; and if you make a calculation you will find that the air in this room at the present time would weigh something about three tons. That, perhaps, you would not expect. Now we have the air here with the whole of the atmosphere above us. Some make the atmosphere of one height, some of another. There are various reasons why we should give

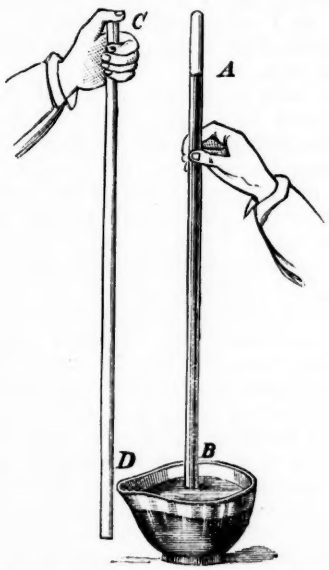
a kind of limit to the height of the atmosphere, but all give it a certain height; some have held it to be about fifty miles in height, others one hundred, others two hundred; but, at all events, whatever the height is these lower strata of the atmosphere have to bear the weight of all the atmosphere above them.

Now, upon my body at the present moment the entire weight of the atmosphere is pressing, and I wish you to clearly realise that this pressure is not only exerted upon my head, which has to bear all the weight of the atmosphere above it, but that it is just as much exerted upon my sides; so that when you calculate the pressure exerted upon the human body, you must take the number of square inches upon the whole of the human body, and you must determine the pressure upon every square inch. What is that pressure? The pressure upon every square inch is exactly equal to that bar of lead, which is a square inch thick and a yard in height. Now, how would you like to bear the weigh of a mass of lead surrounding your body? Well, what does that amount to in its totality? It amounts to a pressure of no less than 14 pounds. Every man here bears a pressure of this kind—a pressure of 14 pounds upon every square inch of his body. The reason why we are not crushed by this pressure is that the liquids of our bodies are nearly incompressible. They are like water, and the air within our bodies is just as much compressed as the air without, so that there is really no difficulty in existing under these circumstances. Well, things went on in this way until one day, as it is said, some gardeners wanted to water their garden in Florence, and they came to Galileo, and told him that they found that the water refused to rise above a certain level in the pump. I will not vouch for the perfect accuracy of this account, but I think that it is very likely that it is correct. Here is a point worth noting. Great inventions are sometimes made before the reasons for them are known. In this way gunpowder was invented. The desire of man to kill his fellow man was so very strong and strenuous that it was the motive power to induce him to select the constituents of gunpowder in their proper proportions, although they knew not one iota about the chemistry of the thing. The chemist came afterwards. But it was not until afterwards that he explained that these men were correct, and that the proportions were remarkably just. And thus, as I have said, great inventions are made before the scientific reasons for these inventions are known. And thus it was with this discovery of the pump.

Well, these Florentine gardeners came to Galileo, and said: "We want to get up water 50 or 60 feet from our pump, but we find that it will not rise to a greater height than 32 feet." The explanation of the pump in those days was what? No explanation at all. It is amazing how the words of a great man can bewilder the world; and that not for a generation, or a century, but for thousands of years. And so it was with Aristotle. He gave an explanation, or, at least, his school gave an explanation of why water rises in a pump. The pump, as you know, is a cylinder with an attached valve, and into this cylinder is inserted a piston. Now, if I lift up this piston there is left behind it what is called a vacuum, that is, a space in which there is no air. And Aristotle's statement was that, as nature abhorred a vacuum, this empty space could not be allowed to exist, and the water ran up to fill the vacuum. Well, Galileo was rather soured by the treatment he had received at the hands of the world. He looked at these gardeners, and he said: "It is quite obvious that nature does not abhor a vacuum beyond a height of 30 or 32 feet." However, the problem was not solved by Galileo. It fell into the hands of his celebrated pupil, Torricelli. Torricelli reasoned thus:— "The atmosphere has weight. Here is a vessel, say, containing water. The atmosphere presses upon that water; and if I, by means of my pump, remove the atmosphere, and so take away the pressure of the atmosphere above the water, the pressure of the atmosphere outside will cause the water to ascend." And what does that show? A thought occurred. First of all, remember, it was only a thought; and that is the way that scientific men advance. They gather up together the knowledge prevalent in their times, and they ask themselves what is likely to result from this knowledge. Torricelli divined the reason with his mind's eye before a human eye ever saw the fact. He said: "If I remove the atmospheric pressure from the interior of my pump, the pressure outside will force the water up; and that column of 32 feet that those gardeners in Florence lifted by their pump answers to the outside pressure of the atmosphere. The 32 feet of water holds the weight of the whole atmosphere in equilibrium." This was his conjecture, but he did not content himself with that reason. He said: "If my reason be correct—if it be the fact that 32 feet of liquid water can hold the pressure or weight of the atmosphere in equilibrium—then, if I take a heavier liquid than water, I must have a shorter column supported. The weight of the atmosphere being a constant thing, will lift a shorter

column of mercury, which is thirteen times heavier than water. If mercury is used instead of water, then, instead of a column of 32 feet being supported, I ought to have a column of only about 30 inches of mercury." I do not know any experiment in the whole course of science that must have carried more high expectation in its train than this experiment of Torricelli. Here is Torricelli's experiment. He filled with mercury a tall glass tube, closed at one end (C D, Fig. 36). He placed his finger, as I do, upon the open

FIG. 36.



end of the tube, and he turned it upside down. He then placed the end closed by the finger underneath the surface of some mercury contained in a vessel, and removed his finger. You understand the conditions of the experiment. When the tube of mercury is thus inverted in a vessel containing mercury, the mercury is exposed to the pressure of the atmosphere. If the pressure of the atmosphere can support the whole of that column, the tube will remain full; but if it can only support 30 inches, as Torricelli surmised, the mercury will descend in the tube. It will not descend quite down, but will stop at a certain point, and then we

shall have a column of mercury that exactly balances the weight of the atmosphere. And there it is, as Torricelli foresaw with the eyes of his mind, the mercury falls until it reaches the point A, the column of mercury, A B (Fig. 36), being about 30 inches in length.

If I take a tube of water instead of mercury, when I invert the tube you will find no depression of the column. The tube will remain full, because the weight of the atmosphere is quite sufficient to keep it full. I invert a tube of water over a vessel of water in the same manner as I did with the mercury, and I withdraw my hand, and the tube remains full, as I anticipated. Here we have, then, this celebrated Torricellian experiment, on which our present barometers depend.

But another wise experiment followed this conjecture of Torricelli. There was a great man in those days named Pascal, and he, writing to his brother-in-law, M. Perrier, proposed an experiment to test the result of Torricelli. He had no doubt of the correctness of the result; but still as a philosopher he thought himself in duty bound to test it in all possible ways, for in the days to which I refer there was a contest between the philosophic spirit, which has now got such complete predominance in the world, and the old Aristotelian spirit, which explained these things in such an extraordinary and unscientific fashion; and hence it is that experiments like those proposed by Pascal had an extraordinary value, because it was the time of conflict between the era of scientific investigation and that era of loose speculation which had preceded it. Pascal wrote to his brother-in-law desiring him to make an experiment upon a celebrated mountain in Auvergne, "for," said Pascal, "if it be that the rising of a column of mercury is due to the pressure of the atmosphere, when we go higher into the atmosphere that column of mercury ought to diminish. The column of mercury supported at the top of the hill ought to be less in height than the column supported at the sea-level." Pascal's remarks at the time were very quaint, and at the same time very sarcastic, because it must be remembered that they were uttered in the midst of a controversy between the new and the preceding philosophy. Pascal writes thus to his brother-in-law:—"You see that if it happens that the weight of the mercury at the top of the hill is less than at the bottom (which I have many reasons to believe, though all those who have thought about it are of a different opinion),"—that is, the preceding philosophers,—"it will follow that the weight and pressure of the air are the sole

cause of this suspension, and not the horror of a vacuum; since it is very certain," he adds, "that there is more air to weight on it at the bottom than at the top: while we cannot say that nature abhors a vacuum at the foot of a mountain more than on its summit." M. Perrier made the experiment. He found, as Pascal had predicted, that the mercury descended as he ascended the mountain, and as he came back again the column ascended, because of the augmented pressure of the atmosphere.

I will just say one or two words with regard to the next great step made in this field. It was a step made by that grand old fellow whom so many of our hearers have reason to know,—the burgomaster of the town of Magdeburg, in Prussia,—Otto von Guericke. This Otto von Guericke, who was the first to make the electric machine with a ball of sulphur which he rubbed in his hands, devised a means of exhausting the air, or taking the air out of a body. The original instrument invented by him for this purpose is still preserved in the city of Berlin.

Another illustration of the weight of the air I wish to give you here. Here is a very strong tin cylinder. I will extract the air from within that cylinder, and by-and-bye you will find that when the pressure within is withdrawn the pressure of the air outside will crush the vessel. [When the exhaustion of the air had proceeded for a short time the tin cylinder suddenly collapsed.]

Now, I want to direct your attention to an experiment bearing upon the result obtained by the gardeners at Florence. Here you see I have a tube 5 feet long. The pressure of the atmosphere lifts the water in that tube so as to fill it, although the same pressure is not competent to support a column of mercury of that height. This tube is prolonged by means of another tube to the base of the building, so that between the top, the glass tube, and the base of the building there is a distance of 33 feet. From the interior of the tube we exhaust the air, and the pressure of the atmosphere upon the surface of the liquid contained in the basin where this tube ends downstairs, forces the liquid up the tube as the vacuum is made. The water reaches a certain point, and then, according to the result enunciated by Galileo, beyond that point it cannot go. It reaches a point where the pressure of the atmosphere upon the basin down stairs is exactly equal to the weight of the column of water that we raise.

ANALYSES OF BOOKS.

Evolution and Involution. By GEORGE THOMSON. London: Trübner and Co.

WE opened this book in the hope of finding here the demonstration of some important and hitherto unrecognised law touching the development of organic existence. We thought that the author might have got sight of what has escaped the vision of Darwin—to wit, the initial cause of those variations which "Natural Selection" at the best can only preserve and accumulate. We were grievously disappointed. The "idea" of the work is probably to test that supposed indefinite quantity, the patience of unfortunate reviewers. We have here a repetition, in its grossest form, of the threadbare and now utterly inexcusable error that Evolutionism is an attack upon the existence of God. We quote the following most deplorable passage:—"Messrs. Darwin, Spencer, Huxley, &c., in England, and a few similarly inspired Germans, Frenchmen, and Americans, have at the appointed time appeared on the stage of existence to enlighten humanity, and to show what stupid fellows all former men have been, and what more stupid fellows we are in adhering so long to anything to which these stupid ancestors have given utterance. It seems that the ancestors of the present races of men somehow stupidly took into their heads that there was a personal God in being, the author and complement of all, and that we more stupidly have been for ages worshipping this imaginary Being by way of praying and singing psalms to Him, and after divers other fashions, all attesting the folly and credulity of the human race. Now, however, there is to be no more of this nonsense and stupidity," &c.

This passage seems doubtless to Mr. George Thomson very killing irony. We can pronounce it nothing but an entire misapprehension of Evolutionist teachings,—a perversion simply disgraceful to its author, who ought before writing on Evolution at any rate to have acquired some acquaintance with its nature and tendencies. Had he been conscientious enough to learn before teaching, he would have found that the "few similarly inspired Germans, &c." comprise well nigh the total body of men capable of understanding the question of the origin of the forms of organic beings; he would have found that the doctrine of Evolution leaves the existence of a personal God precisely where it was before, though it may lead us to different and worthier

conceptions of His mode of creation. He might have found that "Monsieur Comte," whom he curiously mixes up with the Evolutionists, was—like many other men who are neither Christians nor even Theists—a firm upholder of the permanence of species. He might perchance have learnt that the co-discoverer of the principle of "Natural Selection" is the author of the ablest refutation of Hume's argument against miracles, and that though certain believers in Evolution are, in common phraseology, "Infidels," yet their Infidelity and their Evolutionism stand in no causal connection.

To the biologist the work before us is simply something dead. It brings forward no facts either novel or which have escaped notice: it propounds no questions which may be solved by observation and experiment; it throws out no suggestions capable of being followed up. The author's law of "Evolution" and Involution is stated in the following terms:—"All beings in proportion as they assume personality and evolve out of the universe, in that proportion do they involve it within themselves and incorporate it, approaching at the same time absolutism in all its attributes." Concerning this collection of words the author modestly declares that, "like everything that is great, it is so simple and obvious that a child can comprehend it, yet upon this simple law hangs the revelation of existence and being to man." This seems to us one of the many laws which we have heard enunciated which, however simply, lead to nothing.

The Spectroscope in Medicine. By C. A. MacMunn, M.D. With three Chromo-lithographic Plates of Physiological and Pathological Spectra, and thirteen Woodcuts. London: J. and A. Churchill.

That the spectroscope, judiciously applied, is likely to become a valuable guide in Medicine scarcely requires demonstration. It has been already applied with success for ascertaining the presence of abnormal elements, such as the poisonous metals, in the body or its secretions,—a circumstance the more valuable as the quantity of material to be operated upon by the toxicologist may sometimes be too small for the ordinary processes of chemical analysis. According to Dr. Thudichum, morbid gases occurring in the animal economy may be recognised by its use. Dr. Bence Jones has employed the spectroscope for determining the time that certain salts take to reach any part of the body; for finding where diffusing substances go to, how long they are in passing from the stomach into the textures, how long they stay there, and how quickly they cease to appear in the excretions.

Still more instructive is the study of the absorption spectra of

physiological and pathological fluids. The author not merely treats of spectroscopic examination as a means of detecting and recognising blood-stains, but gives an account of the changes produced in the blood by a variety of agencies. Thus we have a description of the spectrum of the blood in death from asphyxia; in death from the inhalation of nitrous oxide, and of carbonic oxide; the spectrum of blood treated with nitrogen dioxide, with sulphuretted hydrogen, with hydrocyanic acid and soluble cyanides. The author next explains the effect upon the blood of nitrites, of ammoniacal gas, of arsenic and antimonic hydrides. The use of such investigations in questions of medical and chemical jurisprudence may fairly be pronounced the smallest part of their value. Bile and urine are next dealt with in a similar manner.

It may doubtless be asked why the spectroscope has not already become one of the recognised auxiliaries of the physician, seeing that it will frequently be of signal use in the diagnosis of disease, in the comprehension of morbid changes, and in tracing them to their cause?

The author considers that many practitioners have been deterred from the use of this instrument by exaggerated ideas of the difficulties involved, and by the want of a simple treatise on its use and on its applications to Physiology and Pathology. Many persons still living will remember the time when the microscope was regarded with a similar distrust, which has only gradually—and we may say not entirely—been got rid of by the appearance of practical works on microscopic manipulation.

Such wants, as regards the spectroscope, the author makes it his business to supply, and in our opinion with very marked success. In the two introductory chapters he explains the essential parts of a spectroscope, the various kinds of spectra, the nature and use of the one- and two-prism chemical spectroscope, the art of mapping spectra, the nature of absorptive as distinguished from bright-line spectra, and the use of the micro-spectroscope. A supplement gives the bibliography of medical and physiological spectroscopy.

This work merits the attention not merely of the physician and the medical student, but of the toxicologist, and of all who engage in biological research. To all of these classes a familiarity with the use of the spectroscope is like the possession of an additional sense, and in acquiring such familiarity they will find Mr. MacMunn's treatise a needful guide. We hope it will enable many aspirants to qualify themselves for research in the fruitful field which Mr. Sorby has cultivated with such success. It must be distinctly remembered that the author is not a mere compiler, having no special and practical acquaintance with the subject of which he treats, but an actual and experienced observer.

A History of the British Marine Polyzoa. By THOMAS HINCKS, B.A., F.R.S. London: John Van Voorst.

WE have here a most elaborate and admirable monograph, drawn up by an author whose prolonged and successful researches in this department of biology specially qualify him for the task. In the Introduction Mr. Hincks treats of the structure of the Polyzoa, their embryology, distribution, and classification, and discusses the meaning of some parts whose function is obscure. Among these is the so-called "brown body" which has given scope to much controversy. Setting aside less probable views, it has been regarded as a mere lifeless residuum of the dead polypide, or as a special structure having a reproductive function. In common with Prof. F. A. Smitt, the author has held the former view, and has supported it by means of original observations. He now, however, considers that the evidence tallies better with the "residuary" theory of Joliet and Nitschke. Still no very satisfactory explanation seems to have been given of the observations of Prof. Smitt and of the author's own.

Another subject of dispute is the function of the "avicularium," which in some genera—*Bugula* and *Bicellaria*—appears as an "articulated assemblage attached to the zoœcium with a formidable hooked beak and a mandible worked by powerful muscles, perpetually snapping its jaws with monotonous energy, and swaying to and fro with vigorous swing on its jointed base—grotesque both in form and movement." Mr. Hincks, who traces the development of this "bird's head" through a long series of gradational forms, considers that its function is defensive rather than subservient to the capture of nourishment. Further observations will here be useful. The passage of the ova into the oœcium or ovicell has not been witnessed, nor is the author aware of any observations showing how it is effected. Mr. Hincks seems to believe not merely that the oœcium acts as a marsupium, but that, under circumstances not explained, ova are produced within it.

On the distribution of the Polyzoa the author remarks that pending the publication of the results of the *Challenger* Expedition generalisation would be premature.

The remainder of the work is devoted to a systematic account of the Polyzoa, and will prove a most useful guide to the student of marine zoology. The work is not merely illustrated with woodcuts introduced in the text, but with eighty-three plates, forming a companion volume. The bibliography of the subject is given in an Appendix.

Biologists will feel greatly indebted to Mr. Hincks for thus placing before them the observations of a lifetime, and will not be slow in acknowledging the merit of the publisher, already so honourably known in the department of Natural History.

Science Primers: Introductory. Py Prof. HUXLEY, F.R.S. London: Macmillan and Co.

WE have here, in the compass of 94 pages, a most useful little book, which ought to circulate widely and to be extensively and carefully read by the young, and by not a few of their elders.

The first section, entitled "Nature and Science," may be likened to a dose of isinglass, as it is well fitted to clarify the popular mind. In it we find a plain account of sensations and things, of causes and effects, properties and powers, of Nature (so-called, accident or chance), of the laws and Nature, and of Science as merely the knowledge of the laws of Nature obtained by observation, experiment, and reasoning. The author easily and completely strips these subjects of the mystery in which they are always wrapped in the minds of the uneducated, and of that more numerous class the miseducated. One abuse of the term Science, very common in England, when, namely, it is confounded with Art, has escaped notice.

The remainder of the work deals in an equally lucid manner with the characteristic phenomena of material objects, mineral and organic, and with those of Mind.

The Geological Record for 1877. An Account of Works on Geology, Mineralogy, and Palæontology, published during the Year, with Supplements for 1874 to 1876. Edited by W. WHITAKER, B.A., F.G.S., of the Geological Survey of England. London: Taylor and Francis.

OUR readers are of course aware of the general character of this useful volume, and will remember that the term "Works" comprises not merely independent publications, but papers from the various scientific journals and from the Transactions of the learned societies. The compilation of such a "Record" involves an immense amount of labour, and such sins of omission and commission as Mr. Whitaker admits in his humorous Preface must be unavoidable. The delay in publication it seems has been caused by that haunting dread of anxious editors, the loss or delay of MS. in transmission. Some person, not named, appears to have got possession of a portion of the copy, and, in vulgar phraseology, to have "stuck to it" for some months.

The value of so complete a conspectus of the geological literature of each succeeding year needs no demonstration.

CORRESPONDENCE.

"INSTINCT AND MIND."

To the Editor of The Journal of Science.

SIR,—In an article in your last month's issue, bearing the above title, the writer, Mr. S. Billing, advances as a distinction between instinct and mind that the former is "tribal," *i.e.*, common to an entire species, variety, or breed. Thus, speaking of different kinds of dogs, he says, "The aptitude of each is tribal; the gaze-hound has not the instinct of the pointer, or the shepherd's dog that of the retriever." Again—"The tribal characteristic is found in the habits of wild animals; particular species of birds have the same constructive instinct; and whenever a variation occurs in a particular species or variety, each member of the class practises the same peculiarities." Now if we are to understand from these passages that all the individuals of any given species or variety stand on the same level in point of intelligence, I must, in the name of all who have closely examined the doings of the lower animals, pronounce Mr. Billing's view utterly at variance with facts. Different breeds of dogs have, of course, peculiarities in common, just as have different races of men. But within each race there occur individual variations in sagacity, just as we find it to be the case in our own species. Thus all shepherd's dogs are to a certain extent similar as contrasted with pointers or retrievers. But to assert that one shepherd's dog is equal in intelligence to every other shepherd's dog is a statement not merely devoid of all foundation, but contrary to distinct observation.* These animals differ among themselves as decidedly, though not to the same extent, as do men. Every now and then we meet with a "collie" who far surpasses the common run of his kindred in perception of what is wanted, and in the variety and extent of his resources. On the other hand, there are stupid collies who are almost worthless to their employers. Similar distinctions between individuals are daily traced in all species with which man comes so closely in contact that he is able to observe them with any approach to accuracy. It is well known that when monkeys of any particular species

* We took a very similar position in our critique on Mr. Billing's interesting work "Scientific Materialism." See Journal of Science for 1879, p. 664.

accumulate at the Zoological Gardens, some of the surplus specimens are sold off. Now I understand that the purchasers often declare themselves willing to pay a much higher price if they might have the animal a few days on trial, so as to find whether he was a clever monkey or a dull one. Whether we accept the old doctrine of a distinction of kind between man and the lower animals, or whether with the modern school we admit a mere difference of degree, there is not, to my knowledge, a shadow of foundation for the mental equality which Mr. Billing ascribes to the members of each species.—I am, &c.,

R. N. M.

THE WILD BIRDS PROTECTION ACT.

To the Editor of the Journal of Science.

Sir,—I was much struck with the article in your last number entitled "Our Friends, and how we Treat them." All that you say about the practical nullity of the Act is true. As far at least as the northern outskirts of London are concerned, the bird-catchers are now daily and successfully at work, and the authorities, police, &c., take not the least notice. I hope that your appeal both to the humanity and the interests of the nation will not be ignored.—I am, &c.,

B. E.

THE ANCESTRY OF MAN.

To the Editor of the Journal of Science.

Sir,—In an article in your April number I find the following words:—"the anthropomorphous apes, which our *savants* mark out as the immediate ancestors of man." I was not aware that any naturalist of standing considered man as descended from any existing anthropoid. It has been expressly declared by the leading Evolutionists that they do not place man on the same ascending line as the gorilla, the chimpanzee, or the orang.—I am, &c.,

Accuracy.

CARNIVOROUS BEES.

To the Editor of the Journal of Science.

SIR,—In the Notes (No. LXXV. of your issue) you have an interesting observation upon bees eating butterflies, and observe that Fritz Müller states that in South Brazil he saw "bees licking the juice dropping from pieces of flesh which had been suspended to dry in the air." In England I have observed both wasps and bees sipping the juices which have exuded from a fresh steak when lying in a plate. I always supposed they did so for the purposes of drink. Mr. Darwin may probably be right, that they tear open the bodies of the moths to get the nectar contained in their stomachs. I think the more probable solution is, when we consider that they are not indifferent to the juice of meat, that the moisture, and not the nectar, is the object of their quest.—I am, &c.,

S. B.

FERTILITY OF HYBRIDS.

To the Editor of the Journal of Science.

SIR,—"Truth-seeker" might have found a more convincing proof of the fertility of hybrids than that he mentions from "the history of the American bison," in the statement of Haeckel, that the progeny of the hare and the rabbit are fertile, and have been so for several generations; he has named the new species *Lepus Huxleyii*.—I am, &c.,

S. B.

[The hybrids which our correspondent mentions are well known in France as *Léporides*, and their fertility is established. But we fail to see that they furnish a more convincing proof than does the fertility of the hybrids between the American bison and the domestic cow.—ED. J. S.]

PAUCITY OF ALMOND BLOSSOMS, &c.

To the Editor of the Journal of Science.

SIR,—The peculiarity of the season this year is curiously exemplified in the blossoming of the almond tree. Generally in February, or early in March, everyone knows that the tree is usually clothed with a profusion of light pink blossoms, with a total absence of green leaf. This year the leaves appear without the blossoms, or if there be any blossoms they are scarcely distinguishable. This is the more to be regretted, as the wall-fruit, peaches, nectarines, and apricots, follow in suit: there are scarcely any blossoms on them. The gardeners explain the phenomenon on the hypothesis of unripened wood.—I am, &c.,

OBSERVER.

Sunbury-on-Thames.

THE COLOUR-SENSE.

To the Editor of the Journal of Science.

SIR,—It has been maintained by Drs. Magnus and Geiger, and I believe by Mr. W. E. Gladstone, that the colour-sense in man is of recent origin. I rather incline to the opinion that it is decaying, if we may judge from the fondness for dull and impure colours now so conspicuous, and which perhaps may be due to the lowering of the tone of the nervous system which the conditions of modern life bring on.

A kindred fact is the love for bitter foods and beverages traceable to the increase of dyspepsia, and most striking among the most dyspeptic peoples.—I am, &c.,

SENEX.

THE MEANING OF BEAUTY.

To the Editor of the Journal of Science.

SIR,—When we see objects openly and conspicuously beautiful to the naked eye, such as certain birds, insects, flowers, &c., we

are apt to think that this wealth of colour and of design exists with reference to man. But suppose we take some such object as the hoof of an ox or an ass, cut a thin section of it in certain directions, and examine it under the microscope with the aid of polarised light: what about the wonderful play of colour then revealed to our vision? Will any teleologist maintain that the minute structure of such hoofs was arranged with any reference to the fact that after the lapse of many thousand years a few microscopists should detect all this beauty?—I am, &c.,

AN EVOLUTIONIST.

NOTES.

PROF. J. T. SHORT has published a work on the "North Americans of Antiquity," in which he contends that the mound-builders were not Red Indians, but were related to the Nahuas of Mexico; that man is not autochthonous in America, and has not been on that continent above 3000 years (?); that the ancient Americans were not a single race; that the Mayas and Nahuas possessed a very high degree of scientific and artistic knowledge, that they reached this continent from opposite directions, and that the civilisation developed by each people is indigenous.

The Influence of Light upon Animal Life.—We summarise here certain observations reported in the "Mittheilungen aus dem Embryologischen Institut zu Wien" (iv., p. 265), and "Untersuchungen zur Naturlehre des Menschen und der Thiere" (xii., p. 266):—It was established by Moleschott, as far back as 1855, that frogs in light exhaled more carbonic acid than in darkness. The question still remained whether a direct action of light upon the chemical process in the animal body was here concerned, or whether the light merely excited the animal to greater vivacity, and thus indirectly occasioned a greater evolution of carbonic acid. This point has been now experimentally decided by Moleschott and Fubini, who arrive at the following conclusions:—The action of light in promoting the metamorphosis of matter is exerted not merely through the eyes, but through the skin, and can be traced even in blind frogs, birds, and mammals. If the eye alone, or the skin alone, is stimulated by light, the increased escape of carbonic acid is smaller than when the entire body is exposed to light. The respiration of the tissues is increased by light in the same manner as the respiration of the entire body. Both in cold-blooded and warm-blooded animals, whether blind or seeing, the excretion of carbonic acid increases with the chemical activity of the light, the violet-blue ray being the most effectual.

Dr. S. L. Schenck has studied the development of tadpoles exposed respectively to red, blue, yellow, and green light, all other conditions being exactly alike. Under the red glass the embryos gave the first signs of movement, and were throughout the experiments the most active. Under the blue glass the exact contrary phenomena were observed. If the liquid was agitated many of them allowed themselves to drift about like lifeless matter. The tadpoles exposed to green and yellow light did not differ in their behaviour from such as were placed in full daylight. Those under the blue light appeared the most ravenous,

but it could not be perceived that they were better nourished than the red. Frog-spawn illuminated from below only was materially retarded in its development. In tadpoles which received light only through a solution of potassic bichromate, cutting off all the rays from violet to yellow, the development of colouring-matter was very imperfect, and the creatures remained pale. In those exposed to light which had traversed an ammoniacal solution of copper oxide, the colouration was perfectly normal.

[We may remark that nothing is recorded of the intensified and increased growth which has been said to result from exposure to blue light. In our own experiments upon insects we have not observed the defective colouration which is here traced to the yellow rays.—Ed. J. S.]

Prof. E. D. Cope, in a lecture on Evolution delivered before the California Academy of Sciences, remarks, concerning the view that consciousness is a kind of force, "To the latter theory I cannot subscribe; when it becomes possible to metamorphose music into potatoes, mathematics into mountains, and natural history into brown paper, then we can identify consciousness with force." He also gives the caution that "Lines of men in whom the sympathetic and generous qualities predominate over the self-preservative must inevitably become extinct."

We learn from the "American Naturalist" that the Chinese starling, the turtle dove, and the European sparrow are now very numerous in the Sandwich Islands, whilst the native birds, even in the interior, are becoming scarce, and are in danger of extinction.

M. Dieulafait, in a memoir recently presented to the Academy of Sciences, shows that copper exists in all plants growing upon rocks of the primary formation, and in such proportion that it may be detected in 1 grm. of their ash even by the ammonia-test. Plants flourishing upon relatively pure calcareous soils do not yield traces of copper. The author is still engaged with the question of the occurrence of this metal as a normal constituent of the animal system. He maintains that heat has taken no share in the formation of the dolomitic regions.

F. K., writing in the "Natur Forscher," points out that in certain geometrical spiders, belonging to the group Nephelinæ, the males are so minute as to have been overlooked or referred elsewhere. This is the case in the genus *Cœrostris* of Africa, and *Celœnia* of Australia.

A technological contemporary informs us that "of the sixty-two primary elements known in Nature, only eighteen are found in the human body, and of these seven are metallic. Iron is found in the blood, phosphorus in the brain, limestone in the bile, lime in the bones, dust and ashes in all." Our chemical

readers will doubtless be puzzled at the three new elementary bodies, limestone, dust, and ashes.

In the "Scottish Naturalist" for April, Col. Drummond Hay shows, from his own observations and those of others, that fruit trees apparently disbudded by the bullfinches in early spring yield in summer luxuriant crops of fruit, the explanation being that the buds removed were infected with vermin, which were thus prevented from spreading. If this view is further confirmed the prejudice against the bullfinch as an enemy to our orchards must be pronounced unfounded.

Four species of *Helix*, including *H. studeriana* from the Seychelles, according to Vignier, bring forth living young.

According to the researches of Dr. Brush, the milk of ruminants, when swallowed, is coagulated by the acids of the stomach into a hard mass. Hence calves, lambs, kids, &c., which have taken no food but the milk of their mothers, always chew the cud. Animals which do not ruminate consequently find a difficulty in digesting the milk of a ruminant species. On the other hand, human milk, and that of mares, asses, and other non-ruminant animals, coagulates into small granular or flocculent masses which are easily digested. Hence, as was intimated in the "Journal of Science" (vi., p. 24), is not a natural food for man, nor for any non-ruminant creature.

According to J. Munk ("Virchow's Archiv.") glycerin does not rank among nutritive bodies. It is completely decomposed in the animal system, mere traces occurring in the urine. No formation of phospho-glyceric or sulpho-glyceric acid was observed.

Dr. Trouessart ("Annales des Sciences Naturelles") has published an investigation of the geographical distribution of the bats in comparison with that of other land mammals. Only two families, the Vespertilionidæ and the Emballonuridæ, are common to both continents. The Pteropodidæ, Rhinolophidæ, and Nyctéridæ are peculiar to the Eastern Hemisphere, and the Phyllostomidæ to the Western. The Vespertilionidæ have two cosmopolitan genera, *Vesperugo* and *Vespertilio*. The headquarters of the Pteropodidæ seem to be New Guinea. The bats do not belong in the neighbourhood of the Primates, but should rank below the Carnivora, with the Insectivora and the Rodents.

M. Flahault communicates to the "Bulletin de la Société Botanique de France" a paper on some exceptional cases where a green colouration appears in plants without the action of light. He finds that the green colouring-matter (chlorophyll) found within opaque seeds has been formed when the enveloping membranes of the seed are still transparent. Chlorophyll can be preserved for a long time in the absence of light. In the embryo

of *Pinus* and *Thuja* chlorophyll is formed in the absence of light at the expense of the nutritive matter previously stored up.

Prof. E. D. Cope points out ("American Naturalist") that, in accordance with what he calls the "Doctrine of the Unspecialised," the perfection produced by each successive age has not been the parent of future perfection. The largest and most perfectly armed animals (*e.g.*, machairodon) have been the first to succumb upon a change of circumstances. The lines of ancestry of the existing higher Mammalia commenced with types of small size.

In a memoir presented to the Academy of Sciences, M. H. Toussaint shows that tuberculosis is easily transmitted by the ingestion of tubercular matter, by heredity or by suckling, by inoculation, and even by simple cohabitation.

According to the experiments of Popoff, yeast proves rapidly fatal if introduced into the blood of vertebrate animals.

M. Giard ("Comptes Rendus," xc., p. 504) points out that the parasitic fungus *Entomophthora* has recently caused an epidemic among insects of the genus *Syrphus*, which are amongst our best destroyers of Aphides.

MM. J. Béchamp and E. Baltus, in a memoir read before the French Academy of Sciences, state that pancreatin, if injected into the veins of an animal, occasions serious functional derangement, and may prove fatal if the proportion reaches 0·15 grm. per kilo. of the weight of the subject operated upon.

M. Domeyko mentions ("Comptes Rendus," xc., p. 504) that the guano of Mejillones contains a considerable proportion of boric acid.

Dr. E. Erlenmeyer gives, in the "Bienen Zeitung," details of experiments showing that bees elaborate their wax from non-azotised matter. Carbo-hydrates serve also for the production of the fat found in the body of the bee. The food of these insects should not be very rich in nitrogenous matter.

Dr. Haberlandt, in the "Œster. Landwith. Wockenblatt," in treating of the cultivation of red clover, urges agriculturists to act upon the discoveries of Darwin, and protect the humble-bees necessary for the fertilisation of the blossoms of this plant.

Wernich, Baumann, and Nencki find it highly probable that bacteria are destroyed by certain products of the putrefaction to which they have themselves given rise. This conclusion seems to throw a light upon the course of certain epidemic diseases, the bacteria which have occasioned the affection being poisoned by the morbid products generated. When this has taken place the patient recovers, unless his vitality has been already exhausted.

According to the "Apotheker Zeitung" Dr. Offenberg has cured a woman who had been severely bitten by a mad dog, and who showed unmistakable symptoms of hydrophobia. He injected curare (woorali) under the skin, to the extent of 3 grains within five hours. The hydrophobic symptoms were overcome, but the specific action of the curare threatened to produce paralysis of the heart and respiratory organs, which was combatted by artificial respiration. Thus Waterton's anticipation of the remedial action of this drug has become a reality.

The Irish Anti-Vivisection Society is making capital out of a letter received from R. G. Butcher, an eminent surgeon, but who, as the "Medical Press" points out, has neither time nor disposition for biological research.

Dr. A. Vans Dunlop has bequeathed about £50,000 to the University of Edinburgh.

We learn from the "Medical Press" that the "Exchange and Mart" is opening a department for the sale of "charity votes."

Thomas Bell, F.R.S., well known for his treatises on "British Reptiles" and "British Quadrupeds," died on March 17th. He was at one time Professor of Zoology at King's College. From 1848 to 1853 he was Secretary of the Royal Society, and from that date to 1861 he held the presidency of the Linnean Society. The remainder of his life he spent at Selborne, in the very house once occupied by Gilbert White.

According to official returns three hundred persons are killed yearly by lightning in the island of Java.

M. Hospitalier, in the "Lumière Electrique," subjects the electric light of M. Tommasi to a very severe criticism, and pronounces its success hopeless.

Mr. D. Brooks concludes, from extended observations, that lightning is more rare in high mountain chains than in comparatively level districts.

According to Mr. Alexander Watt a vast amount of electricity is generated by railway locomotives, but is at present permitted to escape without utilisation.

We learn from the "Electro-Metallurgist" that two Americans, Messrs. Prescott, profess to have discovered that underground currents of electricity, flowing in all directions, form the true "earths" of lightning discharges. They assert that all houses, trees, &c., struck by lightning are underflowed by these currents, and that no houses, &c., standing on spots where there are no currents are ever struck. In protecting a house from lightning stroke, therefore, their method is to test the ground underneath, and if there are no earth-currents below to take no further trouble; but if these currents are present, to earth the

rod, which they erect in the parts of the ground below where they are strongest.

Mr. F. P. Perkins, in a paper read before the Society of Public Analysts, points out the universal presence of starch. In dust, whether suspended in the air or collected from the most varied places, this ingredient can always be recognised. The author therefore justly contended that, especially in chemico-legal investigations, no theories can be founded on its occurrence.

Two serviceable illuminators on the immersion principle have been produced: that by Messrs. Powell and Lealand consists of a combination of lenses capable of transmitting a pencil of light of 130°: it is connected optically with the lower surface of the slide by means of oil of cedar wood. The diaphragm arrangements are simple and effective; the movement of a single lever permits of the employment of a central pencil, or of one or two marginal slots placed at right angles to each other. It is necessary, for the effective use of this condenser, that the objects should be mounted on the under side of the cover glass, and not on the slide. Like most illuminators that are of real utility, it requires some experience to obtain the best effects; it is of great value in resolving difficult lined tests. The illuminator by Mr. J. W. Stephenson, F.R.A.S., consists of a plano-convex lens, worked on a 1-inch tool, and having a diameter of 1·2 inches, which is then "edged down" to 1 inch, as being more convenient in size, and as giving an aperture sufficient for the purpose. The upper or convex side of the lens is cut down or flattened, so as to give a surface four-tenths of an inch in diameter, with which the slide is to be connected, when in use, by a drop of oil or water. The upper curved surface of the lens is silvered, and beneath the lens a flat silvered plate, one-twentieth of an inch thick, and corresponding in size and position with the upper flattened surface, is balsamed. A suitable diaphragm can be placed one-eighth of an inch or less below the condenser. If used with a dry lens of the highest power on a balsam-mounted object, the light, unable to pass the upper surface of the covering glass, is thrown back on the object, giving opaque illumination: on the other hand, with dry objects adhering to the slide, the well-known dark ground illumination can be obtained with almost any objective. The lens should be accurately constructed, as any error in thickness is doubled by reflection.—W. T. Suffolk, F.R.M.S.

Prof. Owen has communicated to the Royal Society an account of the gigantic Australian lizard, *Megalenia prisca*, now extinct. The upper jaw appears to have been sheathed with horn, as in the tortoise. Upon the head were seven horns. Its closely now surviving representative is the diminutive Australian species, *Moloch horridus*.

According to Gautier, Scolosieboff, Caillol, and Liron, under the influence of arsenic an increased quantity of phosphoric acid is eliminated, and the glycero-phosphoric acid of the brain is replaced by glycero-arsenic acid.

Mr. J. Evans has presented to the Royal Society a report, by Mr. A. Hart Everett, on the exploration of the caves of Borneo. The results may be pronounced mainly of a negative character. Human and animal bones have been found in the caves, but no light has been thrown on the origin of the human race, the history of the development of the fauna characterising the Indo-Malayan sub-region has not been advanced, nor has any evidence been obtained showing what races of men inhabited Borneo previously to the immigration of the Malayan tribes. The north-west of Borneo has probably been elevated above the waters of the sea at too recent a date to give room to hopes of discovering cave-deposits of higher antiquity. Mr. Everett recommends explorations in the loftier portions of the island in the north-east.

The "Telegraphic Journal" of April 1st contains a description of a new form of lamp for the electric light, which has recently been invented by Mr. Charles Stewart, M.A. It consists of a number of square carbon rods placed radially upon a disk of wood or metal in such a manner that the inner ends of the carbon rods form a complete circle. There is a circular opening in the wooden disk through which the electric light is seen from underneath. The carbons, which are all forced towards the centre by a uniform pressure, move forward as they are consumed, and together form the positive electrode of the lamp. The negative electrode consists of a covered hemispherical cup of copper, which, before the current enters the lamp, rests upon the ring formed by the carbons. On the current entering the lamp an electro-magnet raises the metal electrode, and the electric arc is then formed between the circle of carbons and the metal electrode. There is a flow of water through the latter to keep it cool. The advantages which this lamp possesses are—(1.) It is automatic in its action. (2.) It is capable of burning for a very considerable period. (3.) It does not throw any shadows. (4.) It is of simple and comparatively inexpensive construction. (5.) The intensity of the light may be increased if so desired. This is the second lamp for the electric light which Mr. Stewart has recently invented.

ERRATUM.

Page 185, line 6 from bottom, *for* "oxygen and nitrogen" *read* "oxygen and hydrogen."

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